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PRELIMINARY (30 PERCENT) DESIGN REPORT FOR BOWERS LANDFILL CIRCLEVILLE, OHIO

Letter from J & ACE

Prepared For

U.S. ENVIRONMENTAL PROTECTION AGENCY
Region 5 Remedial and Enforcement Response Branch
Chicago, IL 60604

Work Assignment No.	:	19-5NA4
Date Prepared	:	November 14, 1990
Contract No.	:	68-W8-0084
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November 14, 1990

Mr. David Wilson
Remedial Project Manager
Remedial and Enforcement Response Branch
U.S. EPA Region 5
230 South Dearborn Street
Chicago, IL 60604

Subject: Preliminary (30 Percent) Design Report for Bowers Landfill, Circleville, Ohio -- (ARCS Work Assignment No. 19-5NA4)

Dear Mr. Wilson:

Enclosed are three copies of the Preliminary (30 Percent) Design Report for Bowers Landfill. This report describes the technical requirements of the remedial design (RD) and incorporates the results of geotechnical and soil gas investigations conducted by PRC in July 1990. The report also discusses the overall strategy and basis for the RD and presents the major assumptions needed to develop the design. PRC has revised the report to incorporate both U.S. EPA and Ohio EPA comments on the agency review draft that was submitted on October 23.

Please call me at (312) 856-8700 if you have questions or comments on the preliminary design report.

Sincerely,

John Dirgo

John Dirgo
Site Manager

cc: William Miner, PRC (letter only)
Diana Bynum, OEPA
Kathy Davidson, OEPA
Bowers Landfill Information Committee

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1.0 INTRODUCTION

PRC Environmental Management, Inc. (PRC) is assisting the U.S. Environmental Protection Agency (U.S. EPA) in the remedial design (RD) for the Bowers Landfill Superfund site near Circleville, Ohio. This preliminary design report, prepared under the ARCS Contract (No. 68-W8-0084), Work Assignment No. 19-5NA4, represents the 30 percent level of the prepared remedial design. This report has been prepared to satisfy the requirements outlined in U.S. EPA's scope of work (SOW), and the Record of Decision (ROD) for the Bowers site signed on March 31, 1989 (U.S. EPA, 1989a). Also, the report was prepared to meet the objectives outlined in PRC's Revised Work Plan for the RD dated January 22, 1990 (PRC, 1990a).

1.1 REPORT OBJECTIVE

The objective of this preliminary design is to develop conceptual construction plans and specifications for conducting U.S. EPA's selected remedial action at Bowers Landfill. This 30-percent design report discusses the design elements and their rationale and presents preliminary drawings and the construction plan and schedule for the remedial design of a landfill cover. PRC will not produce the detailed design drawings and specifications for the pre-final design (95 percent) until U.S. EPA and Ohio Environmental Protection Agency (OEPA) have agreed upon the contents of this preliminary design report. PRC will develop the final design in accordance with the requirements of the ROD, the scope of work for this assignment, and any relevant U.S. EPA guidance documents such as Superfund Remedial Design and Remedial Action Guidance (U.S. EPA, 1986a). The final design documents submitted by PRC will be suitable for inclusion in a bid package. U.S. EPA may use the final design documents to solicit bids from contractors capable of constructing the remedial design.

1.2 DESIGN COMPONENTS

U.S. EPA's ROD selected capping of the landfill as the remedial action for Bowers Landfill. The action includes six major components:

1. Removing surface debris and vegetation from the landfill.
2. Installing a low-permeability clay cover on the landfill.
3. Constructing erosion control measures and drainage improvements.
4. Restricting site access and use.
5. Maintaining the clay cover after construction.
6. Monitoring ground water and surface water.

In addition to the above components, a seventh component, a gas venting system will be part of the remedial design. The gas venting system was added to the remedial design because methane gas was detected during a pre-design soil gas survey at Bowers Landfill.

1.3 REPORT DESCRIPTION

The seven major elements are addressed in the following sections of this report. Section 2 summarizes the results of the remedial investigation (RI), and Section 3 presents preliminary results of the subsequent pre-design field investigations undertaken in July and August 1990. Technical memoranda have been completed for the soil gas survey and geotechnical study. The ground-water technical memorandum will be prepared after the analytical results have been received. Section 4 discusses the environmental impacts of cap construction in a 100-year floodplain and of a wetland area that will be created when the soils for the landfill cover are excavated from fields adjacent to the landfill. Section 5 discusses managing of surface debris on the landfill and on a hill east of a drainage ditch that runs along the east side of the landfill. The gas venting system is discussed in Section 6, and the cap design is presented in Section 7. Erosion protection and drainage improvements are discussed in Section 8. Section 9 discusses institutional controls such as site fencing and sign posting. The operation and maintenance plan, including ground water monitoring, is introduced in Section 10. A construction schedule is introduced in Section 11, and cost estimates are presented in Section 12. The construction quality assurance plan and the health and safety plan are introduced in Sections 13 and 14. Preliminary drawings and an outline of the contract specifications are presented in Sections 15 and 16.

2.0 SITE BACKGROUND

This section briefly describes the Bowers Landfill site and presents information on the site history, levels of contamination, and potential site risks. More detailed information is included in the Bowers Landfill RI report (Dames & Moore, 1988) and endangerment assessment (EA) report (PRC, 1988).

2.1 SITE DESCRIPTION

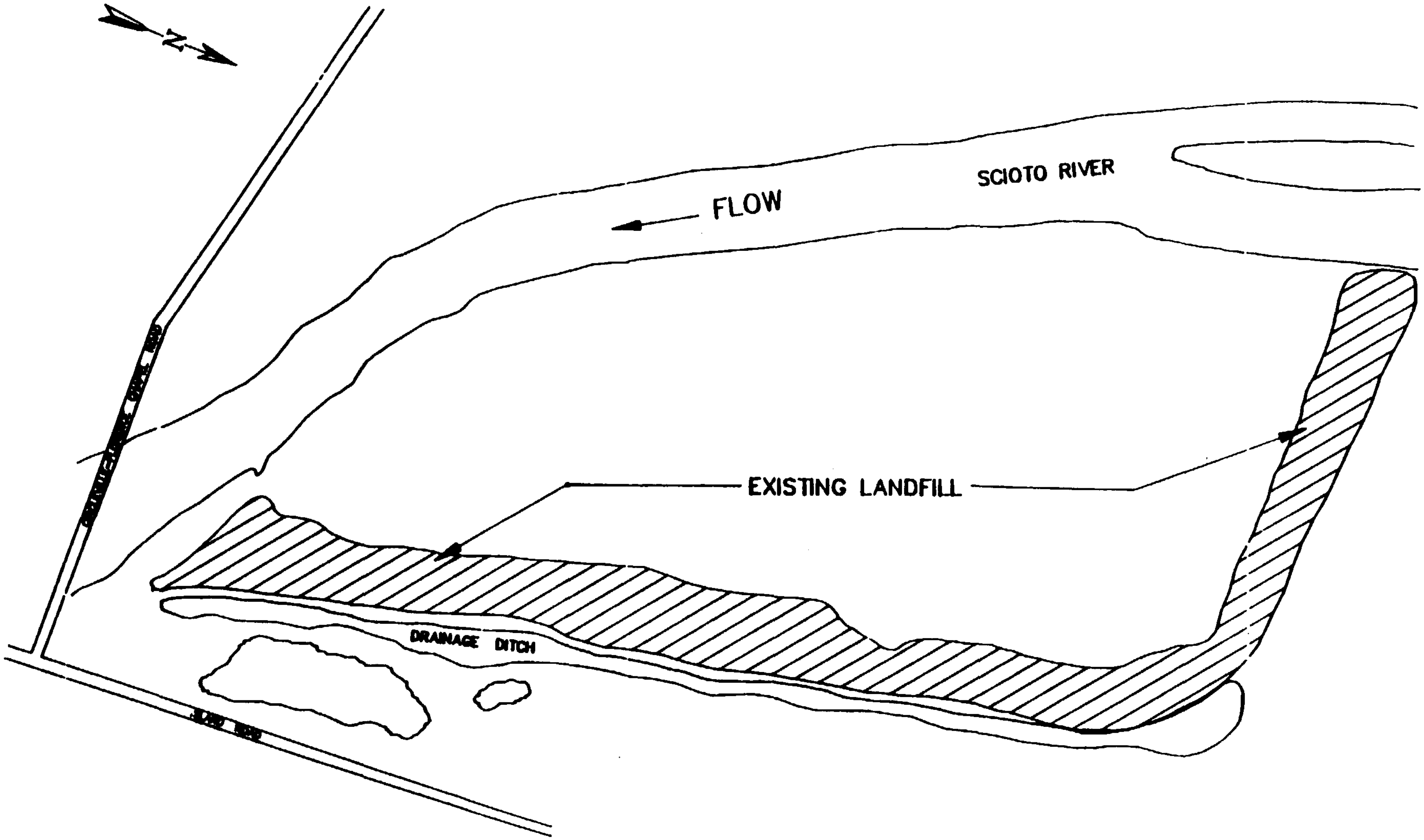
Bowers Landfill is located in rural Pickaway County, Ohio, approximately 2.5 miles north of the City of Circleville. The site is just northwest of the intersection of Circleville-Florence Chapel Road and Island Road, on the east side of the Scioto River Valley. The landfill lies within the Scioto River floodplain, and its northwestern and southernmost points abut the Scioto River (Figure 2-1). The north and west sides of the landfill are bordered by agricultural fields.

The landfill occupies about 10 acres of a 202-acre tract originally owned by the estate of Dr. John M. Bowers. Much of this tract is still owned by the Bowers estate, but portions have been sold to other owners. The landfill was constructed as a berm approximately 3,500 feet long with an average width of 125 feet and a top height approximately 10 feet above grade. The reported waste volume of the landfill is approximately 130,000 cubic yards. Site records, although limited, indicate that some of the waste disposed of in the landfill was hazardous. The landfill has an established cover of vegetation, but miscellaneous debris is exposed where the cover has been eroded.

Because the landfill lies within the Scioto River floodplain, it is flooded regularly. The field west of the landfill is inundated an average of 29 days per year, and parts of the landfill are overtopped by flood waters an average of every 2 years. Flood waters and precipitation draining from the landfill generally flow west and south toward the Scioto River.

A drainage ditch lies immediately east of the landfill. When the landfill was constructed, water in this ditch flowed through a pipe under the southern end of the landfill and discharged to the Scioto River. Over time, the pipe has been clogged by sediment and other debris, and drainage from the ditch is slow. Water now discharges from the southern end of the ditch as a seep or spring in the bank of the river. During high water conditions, water also discharges from the northern end of the ditch to the field north of the landfill.

A second ditch is located on the west side of the landfill. This ditch is not well developed and does not discharge to the river. Water in the ditch tends to pond near the southern end of



BOWERS LANDFILL
CIRCLEVILLE, OHIO

FIGURE 2-1
SITE MAP

PRC ENVIRONMENTAL MANAGEMENT, INC.

the landfill and in other locations along the west side of the landfill.

The site area is rural, with 15 houses located within a ½-mile radius of the landfill. Houses in this area largely depend on private wells for water supply. However, no downgradient wells are within 1000 feet of the site. The City of Circleville's water supply wells are located about 1½ miles south of the site.

2.2 SITE HISTORY

Dr. Bowers began operating the landfill in 1958. Little information is available on the types and quantities of wastes disposed of at Bowers Landfill. However, information from OEPA files indicates that general domestic waste and industrial refuse, collected by private haulers in and around Circleville, account for most of the material in the landfill. Between 1963 and 1968, the site also received chemical wastes originating from local industries, including E.I. DuPont deNemours & Company (DuPont) and Pittsburgh Plate Glass, Inc., now PPG Industries, Inc., (PPG). DuPont and PPG reported sending 6,000 and 1,700 tons of waste, respectively, to Bowers Landfill between 1965 and 1968. Both companies are considered potentially responsible parties (PRP) for contamination at the landfill.

Waste disposal practices consisted largely of dumping waste directly onto the ground and covering it with soil. However, the southern end of the landfill may have been excavated for waste disposal. Waste was also burned at the site, but the extent and dates of waste burning are not known. Landfilling at the site ended around 1968. The site was not secured when landfilling ended, and the cover material of sand, gravel, and some topsoil was characterized as "not sufficient" during a 1971 inspection by the Pickaway County Health Department.

Between 1980 and 1982, U.S. EPA, OEPA, and an engineering firm (Burgess & Niple, Limited, Columbus, Ohio) collected ground-water and surface water samples at Bowers Landfill. Results from these early samples showed that contaminants were being released from the landfill. Volatile organic compounds (VOC), including ethylbenzene, toluene, and xylene, were detected in monitoring wells and in surface water samples collected immediately west of the landfill. Ground-water concentrations as high as 86 mg/L (xylene) and surface water concentrations as high as 48 mg/L (toluene) were found.

Based on these results, OEPA requested in 1982 that Bowers Landfill be placed on the National Priorities List (NPL) of Superfund sites, and the site was added to the NPL in September 1983. In 1985, U.S. EPA and OEPA signed a consent order with DuPont and PPG, allowing the companies to conduct the remedial investigation (RI) and feasibility study (FS).

Dames & Moore conducted these studies between July 1986 and February 1989 under contract to DuPont and PPG. After reviewing the results of these studies and of the endangerment assessment (EA) (PRC, 1988), U.S. EPA (1989a) issued a ROD for Bowers Landfill on March 31, 1989.

2.3 ENVIRONMENTAL SETTING

The environmental setting of the area near the Bowers Landfill site, including information about the climate, soils, surface water hydrology, geologic conditions, and hydrogeologic conditions is described in detail in the Bowers Landfill RI report (Dames & Moore, 1988).

2.3.1 Climate

Pickaway County has cold, windy winters and hot, humid summers. The average minimum temperature in the winter is 24°F, and the average daily maximum temperature in the summer is about 85°F (U.S.D.A., 1980). Sixty percent of the total annual precipitation falls in the 6-month period from April through September. The average seasonal snowfall is 13 inches. On average, the field between the landfill and the Scioto River is under water for about 29 days, usually in the spring and winter (Burgess & Niple, 1981).

2.3.2 Soils

The soil types found in the area of the site are from the Eldean-Genesee-Warsaw association. These are nearly level to sloping, well drained soils formed in moderately fine textured to coarse textured glacial outwash and alluvium. The field area of the site is described as Genesee silt loam, and the northeast corner of the landfill is described as Shoals silt loam. The soil types are also described in Section 3.1 of this report, geotechnical field testing.

2.3.3 Surface Water Hydrology

The Scioto River, which borders the western edge of the Bowers Landfill site, flows south from an area northwest of Columbus and empties into the Ohio River near Portsmouth, Ohio. Flooding data is described in detail in the RI report (Dames & Moore, 1988). During the remedial design stage, from March to September 1990, the field west of the Bowers landfill flooded approximately four times.

2.3.4 Geology

The geology in the vicinity of the landfill site consists of unconsolidated glacial and alluvial (stream) deposits, and underlying consolidated rock strata. An unusual feature, called Eskers, occurs in the area. The Eskers are several long linear ridges composed of sand and gravel, lying parallel to the Scioto River. They were deposited by meltwater flowing through ice tunnels under or within a glacier.

The Bowers Landfill site is underlain by 40 to 100 feet of glacial deposits, which overlie shale bedrock. These deposits are described below in descending order.

- The surface of the site is characterized by the presence of silty clay and clay, averaging approximately 10 feet in thickness. This material appears to be continuous over much of the site and the west field.
- Underlying the layer of clay is a zone of sand and gravel, varying in thickness from approximately 25 to 30 feet.
- The sand and gravel deposit is underlain by a 10- to 20-foot-thick gray silt-clay zone, which appears to be glacial till.
- Gray sand with a small amount of gravel is present beneath the till at most locations.

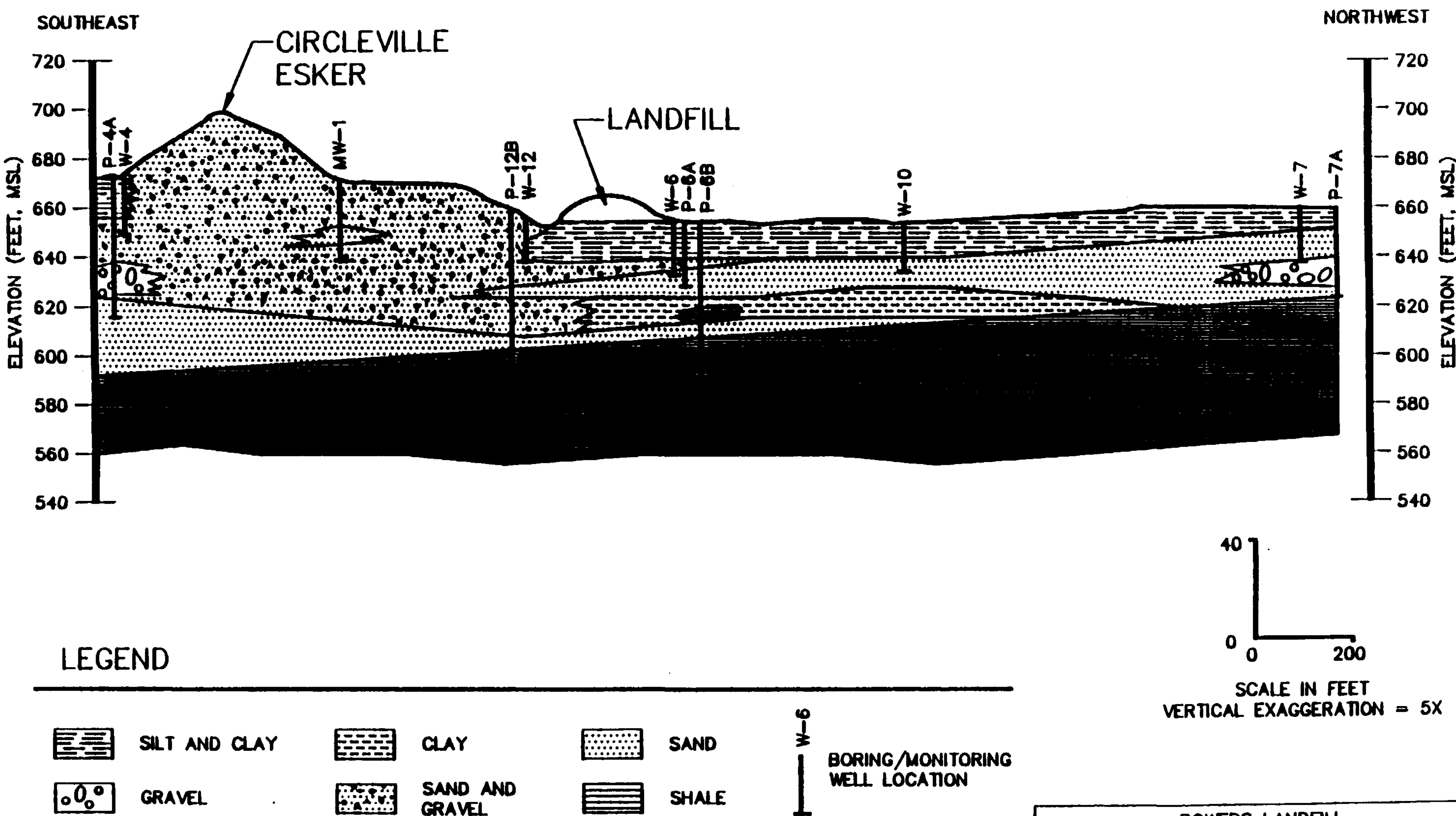
Figure 2-2 illustrates an east-to-west geologic cross-section of the site area.

2.3.5 Hydrogeology

The glacial deposits are part of an extensive aquifer system that underlies the Scioto River floodplain. The deposits include two water-bearing zones -- (1) the sand and gravel deposit approximately 10 feet below the land surface and (2) the sand deposit with lesser amounts of gravel just above the bedrock. These two zones, considered the upper and lower aquifers, are separated by a low-permeability silt-clay deposit over portions of the site. The two aquifers appear to be hydraulically connected at some site locations; however, in much of the Circleville area, the aquifers function as a single aquifer system (Norris, 1975). The bedrock below the glacial deposits is considered an aquiclude and is not used locally for water supply. Hydrogeologic conditions are discussed further in the RI report (Dames & Moore, 1988).

2.4 SITE CONTAMINATION

The RI included on-site scientific studies and laboratory analyses to determine the nature and extent of contamination at Bowers Landfill. This investigation included sampling of ground



BOWERS LANDFILL
CIRCLEVILLE, OHIO

FIGURE 2-2

GEOLOGIC CROSS-SECTION OF THE SITE AREA

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water, surface water and sediments, soil, and air. Levels of contamination measured during the RI were much lower than in samples collected from 1980 to 1982, and are summarized below.

2.4.1 Ground Water

Dames & Moore installed 20 ground-water monitoring wells as part of the RI. Fifteen shallow and intermediate depth wells were screened in the upper aquifer, while five deep wells were screened in the lower aquifer. Water level measurements from these wells indicated that ground water near the site is moving west or southwest. This has been confirmed by additional water level measurements made by PRC in February and August 1990.

Ground-water samples were collected from monitoring wells in February 1987, May 1987, and March 1988. Four residential wells were also sampled in February 1987. All samples were analyzed for VOCs, semivolatile organic compounds (SVOC), pesticides, polychlorinated biphenyls (PCB), metals, cyanide, and dioxin.

VOCs including acetone, methylene chloride, tetrachloroethene, and benzene were detected at low concentrations in some ground-water samples taken from monitoring wells at or near the site. Benzene (6 μg/L) was found in one sample at a concentration above the U.S. EPA drinking water standard of 5 μg/L. Four SVOCs were identified, with most concentrations at levels below U.S. EPA-specified detection limits. A number of metals were also detected in ground-water monitoring wells. All levels except those for barium were below U.S. EPA drinking water standards. Barium was detected above the drinking water standard of 1,000 μg/L in all three samples collected from one well.

Residential wells do not appear to be affected by releases from the site. In addition, sampling results from the Circleville municipal well field, located 1½ miles south of the landfill, show that the well field has not been affected by Bowers Landfill. Ground-water contamination resulting from the landfill appears to be confined to the area between the landfill and the Scioto River.

2.4.2 Surface Water and Sediment

Surface water and sediment samples were collected from 12 locations in the Scioto River and nearby surface water bodies. These samples were analyzed for VOCs, SVOCs, pesticides, PCBs, metals, cyanide, and dioxin.

Methylene chloride, tetrachloroethene, and 1,2-dichloroethane were found at low levels (up to 5.7 µg/L) in the river downstream of the landfill and in drainage ditches near the landfill. However, methylene chloride and tetrachloroethene were found at similar concentrations in upstream background samples. Aroclor-1260, a PCB, was found in two surface water samples collected from the Scioto River, one upstream and one downstream. Aluminum, barium, chromium, and mercury were each found above upstream background concentrations in at least one sample.

Several organic compounds were detected in sediment samples. PCBs were detected at three locations in drainage ditches adjacent to the northern part of the landfill. The maximum concentration detected was 2,300 µg/kg. Chlordane, a pesticide, was found at three locations near the southern end of the landfill at concentrations up to 200 µg/kg. The occurrence of 4-methylphenol appears to be concentrated near the southern end of the landfill and the drainage ditch to the east. This SVOC was found at a maximum concentration of 8,600 µg/kg.

Several metals were found above background levels in sediment samples. These include aluminum, barium, cadmium, chromium, lead, mercury, vanadium, and zinc. However, no metal was found at elevated levels in more than 4 of the 12 sampling locations.

2.4.3 Soils

Surface soil samples collected at 22 locations during the RI were analyzed for VOCs, SVOCs, pesticides, PCBs, metals, cyanide, and dioxin. Polynuclear aromatic hydrocarbons (PAH), a class of SVOCs, were found at elevated concentrations in two sampling locations -- near the center of the landfill and near the southern end. Three pesticides (ß-BHC, dieldrin, and chlordane) were found in soil samples from the field west of the landfill and may be due to past agricultural activities. The maximum concentration detected was 210 µg/kg of chlordane. PCBs were detected in soil samples at nine locations. Eight of these locations are on or directly adjacent to the landfill. Thus, the presence of PCBs appears to be related to landfilling activities. The highest concentration measured was 3,600 µg/kg. Several metals were also found in soils near the landfill at concentrations higher than off-site background levels. These include aluminum, cobalt, lead, vanadium, and zinc.

2.4.4 Air

No quantitative air samples were collected during the RI at Bowers Landfill. Thus, the extent of air contamination at the site is not known. However, air monitoring was conducted with survey instruments during the RI. On-site concentrations of VOCs, combustible gases, and radiation were not elevated above background levels. PRC conducted similar air monitoring for VOCs and combustible gases during RD field investigations. Again, on-site concentrations were not elevated above background levels.

2.5 POTENTIAL SITE RISKS

In preparing the EA for Bowers Landfill, PRC (1988) used standard U.S. EPA procedures to identify the chemicals most likely to cause harmful effects. These chemicals included three metals (barium, lead, and mercury); two VOCs (benzene and tetrachloroethene); two SVOCs (4-methylphenol and PAHs); PCBs; and one pesticide (chlordane). The EA evaluated potential exposure to these chemicals and found potentially significant risks resulting from five scenarios.

The ROD identified risks from two of these five scenarios (exposure to contaminated ground water and exposure to contaminated soil) as the principal threats to be addressed by the remedial action. In addition, the ROD required the remedial action to address the potential risk posed by future contaminant releases from the landfill. Each risk is described briefly in the following sections.

2.5.1 Risks from Ingesting Ground Water

Based on sample results from 13 downgradient monitoring wells, the EA identified a potential risk from drinking ground water immediately downgradient of the landfill. Ground water was found to contain barium (a noncarcinogen) and benzene (a carcinogen) at concentrations above U.S. EPA Maximum Contaminant Levels (MCL) for drinking water. Each chemical was found above the MCL in one well. Worst-case exposure doses were calculated based on drinking 2 liters per day of ground water containing maximum chemical concentrations. Noncarcinogenic risks were estimated by calculating a Hazard Index (HI), the ratio of the estimated dose to the acceptable dose. This ratio was 1.04 for the maximum barium concentration, indicating that the estimated dose exceeded the acceptable dose. Carcinogenic risks for benzene were estimated by multiplying the exposure dose by the cancer potency factor (CPF). For worst-case exposure conditions, this risk was 9×10^{-6}.

These risks are potentially significant. However, ground water downgradient of the site, between the landfill and the Scioto River, is not currently used as a drinking water source. Further, this area is often flooded and is not a likely location for future drinking water wells.

The EA also looked at risks to current users of ground water near Bowers Landfill. Four residential wells were sampled during the RI, but showed no effects of the landfill on water quality. The City of Circleville water supply is also of concern. Based on a review of water quality sampling data submitted by the city to the Ohio Department of Health over an 8-year period from 1980 to 1987, there is no evidence that Bowers Landfill has affected Circleville's water supply.

2.5.2 Risks from Ingesting Soils

The EA identified a potential risk from ingesting contaminated soils at or near Bowers Landfill. Worst-case doses from this exposure were calculated based on ingesting 1.0 g/day (10 days per year over a 3-year period) of soil containing maximum chemical concentrations. Under worst-case conditions, the total HI was 3.48, indicating that the estimated dose for noncarcinogenic chemicals exceeded the acceptable dose. For carcinogenic chemicals under worst-case exposure conditions, the total cancer risk was 3×10^{-6}.

2.5.3 Potential Future Risks

Even though contaminant concentrations measured during the RI are relatively low, the landfill represents a potential threat of future contaminant releases that may endanger public health, welfare, and the environment. First, portions of the landfill are poorly covered, and in some areas, wastes lie less than 1 foot below the surface. Second, although operating records for Bowers Landfill are poor, evidence exists that hazardous substances were placed in the landfill. Finally, regular flooding of the Scioto River also contributes to the threat of future contaminant releases. Based on flood stage data for the river and the height of the landfill, portions of the landfill are overtopped by 2-year floods.

3.0 FIELD TESTING

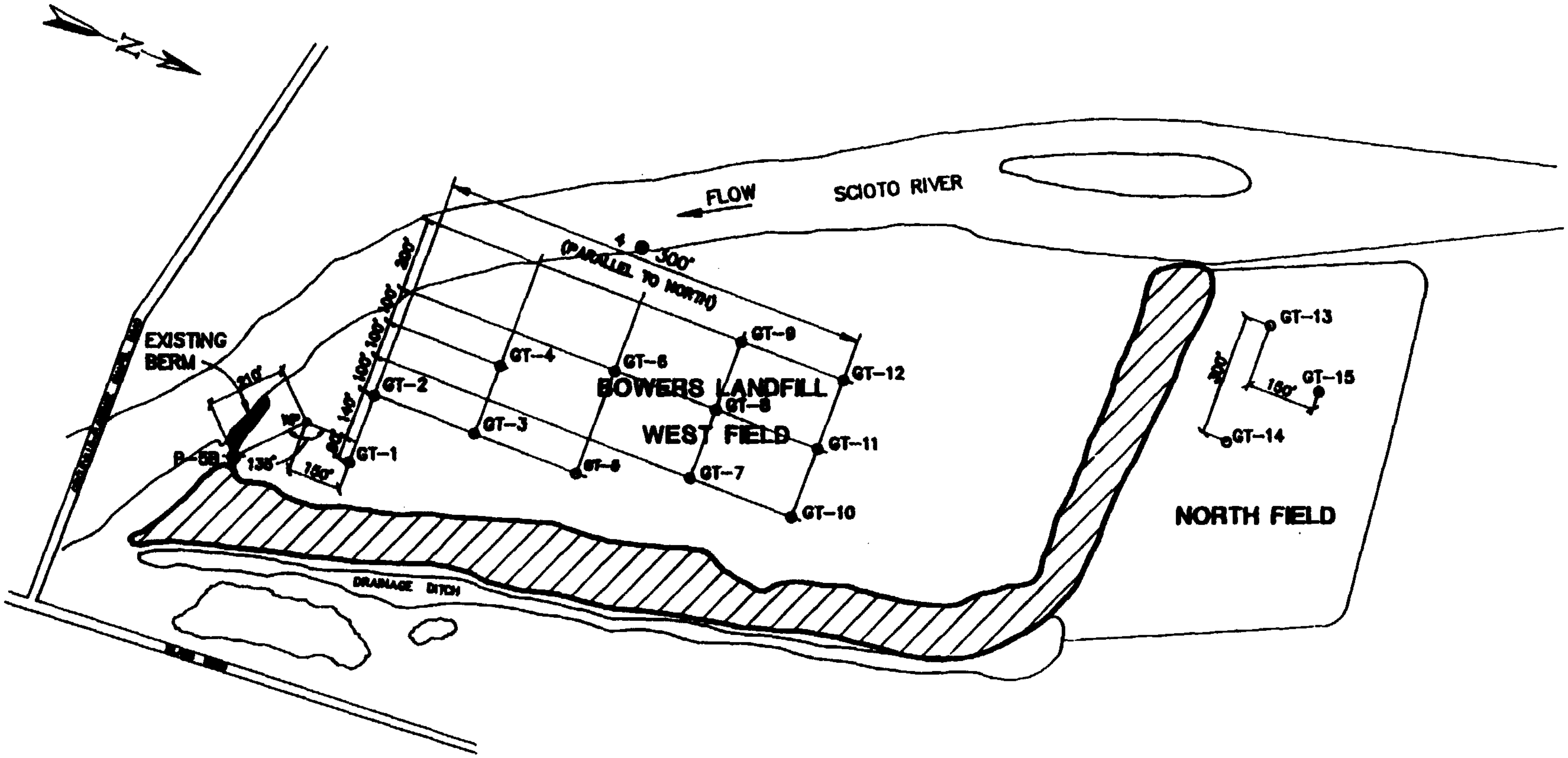
As part of this RD work assignment, PRC conducted two pre-design field investigations specifically identified in the ROD -- (1) a geotechnical investigation to evaluate the properties of potential cover materials and (2) a soil gas study to determine whether a gas venting system should be included as part of the landfill cover. Geotechnical and soil gas sampling were completed in July 1990. In addition, PRC conducted a third field investigation deemed necessary by U.S. EPA and OEPA -- sampling ground water from existing monitoring wells at Bowers Landfill and surface water from two locations in the eastern drainage ditch. This sampling was completed in August 1990. Each sampling investigation is described in the following sections.

3.1 GEOTECHNICAL TESTING

PRC conducted geotechnical sampling and testing at the Bowers Landfill site as a pre-remedial design activity to (1) evaluate whether topsoil and clay in the north and west field adjacent to the landfill contain the required volume of materials suitable for the landfill cover, (2) obtain soil properties to determine slope stability of the landfill, and (3) examine subsurface material in a low berm along the Scioto River at the southwest end of the landfill. The cover specified in the ROD consists of two layers -- a low permeability clay layer, 24 inches thick and with a maximum permeability of 10^{-7} cm/sec; and a topsoil layer, at least 24 inches thick, which is to be seeded, watered, and fertilized to ensure plant growth. The berm was investigated to determine if waste is buried within the berm area.

PRC retained Mason-de Vertuil (MdV) Geotechnical Services of Columbus, Ohio, to collect samples, excavate the berm, and conduct laboratory tests. PRC and MdV conducted geotechnical sampling and berm excavation from July 9 through July 12, 1990. To meet the geotechnical testing objectives, PRC and MdV collected and tested 15 samples from 12 locations in the west field and three samples from three locations in the north field. PRC selected these numbers and locations so that enough samples were collected from fields to evaluate variations in soil characteristics and properties. The sampling locations are shown on Figure 3-1.

Geotechnical testing and analysis was performed by MdV in its soil testing laboratory in Columbus, Ohio. This work was performed in accordance with the required analytical services described in Appendix D of the Quality Assurance Project Plan (QAPjP) (PRC, 1990b). MdV completed testing and analysis and prepared a report containing copies of the chain-of-custody records, laboratory results, and raw data sheets of laboratory tests. This report was submitted to PRC on August 3, 1990. Details of geotechnical sampling and testing are contained in the



LEGEND:

- EXISTING LANDFILL
- EXISTING BERM
- EXISTING MONITORING WELL
- GEOTECHNICAL SAMPLING LOCATIONS

0 500
SCALE IN FEET

BOWERS LANDFILL
CIRCLEVILLE, OHIO

FIGURE 3-1
GEOTECHNICAL SAMPLING LOCATIONS

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Geotechnical Investigation Results for Bowers Landfill Technical Memorandum (TM) (PRC, 1990c). Compaction and permeability test results on bulk soil samples are presented in Table 3-1.

From the results, five samples at the southern end of the west field failed to meet the required permeability, which constitutes a 33-percent failure. These samples were found to contain a large quantity of sandy materials ranging from 30 to 70 percent, which explains the failure (for example, sample GT-04 had the highest permeability, 322.3 x 10^{-7} cm/sec, and it had a 70-percent sand content). This was consistent with the RI study and geologic cross-sections, which indicate shallow sand strata on the southern part of the west field. All remaining samples met the permeability requirements. The permeability results varied from approximately 7 x 10^{-9} to 1 x 10^{-7} cm/sec. Most of these samples were collected from the central and northern parts of the west field and the north field.

On the basis of the estimated depth of clay from the RI study, the west and north fields contain more than adequate amounts of clay suitable for the landfill cap. Also, on the basis of field observations and measurements, adequate material is available for the topsoil cover.

The excavation of the berm at the southwest end of the landfill produced small amounts of construction debris, but no hazardous materials were found. The debris found was probably buried unintentionally during grading of the berm. The berm will be excavated and placed on the landfill prior to installing the new cover.

The testing and analysis also produced data related to the physical characteristics of soil samples, such as density, moisture content, particle size distribution, and compression and shear strengths. This data will be used for determining stability of the landfill cap side slopes and for evaluating cap erosion protection. The data will also be used for preparing specifications for material selection, compaction, and testing.

3.2 SOIL GAS SURVEY

PRC conducted a soil gas survey at Bowers Landfill from July 9 through 13, 1990. The primary objective of this survey was to determine whether a gas collection and venting system was needed as part of the landfill cap. To meet this objective, PRC measured methane concentrations in gases 2 to 3 feet below the landfill surface. High levels of methane could indicate the potential for a buildup of pressure under the new, low-permeability cover, with possible damage to the cover over time.

TABLE 3-1

BOWERS LANDFILL
RESULTS OF GEOTECHNICAL TESTING AND ANALYSIS
BULK SOIL SAMPLES

Sample Location	Sample No.	Max. Dry Density (lbs/ cu. ft.)	Optimum Moisture Content (%)	Test Dry Density[c] (lbs/cu. ft.)	Test Moisture Content[d] (%)	Permeability ($x\ 10^{-7}$ cm/sec)
GT-01	GT-01-B-05	98.6	23.5	98.0	23.8	0.213
GT-02	GT-02-B-05	99.2	21.3	98.9	21.0	2.477
GT-03	GT-03-B-05	102.4	20.6	101.7	21.0	0.526
GT-04	GT-04-B-05	113.5	14.8	113.6	13.9	322.300
GT-05	GT-05-B-05	108.1	17.6	108.1	17.9	3.766
GT-06	GT-06-B-05	110.1	16.8	109.5	17.0	1.905
GT-06	GT-06-B-05[a]	109.8	16.8	109.3	17.3	1.286
GT-07	GT-07-B-05	97.3	24.0	96.9	24.5	0.402
GT-08	GT-08-B-10	102.4	21.0	102.4	21.3	0.380
GT-08	GT-08-B-05	102.3	20.8	101.9	20.9	1.000
GT-09	GT-09-B-05	114.5	14.9	113.5	15.1	8.649
GT-10	GT-10-B-05A	97.6	24.0	97.5	23.9	0.068
GT-10	GT-10-B-05B[b]	99.1	23.1	98.6	23.4	0.998
GT-11	GT-11-B-05	95.5	24.5	95.5	24.3	0.338
GT-11	GT-11-B-10	98.0	24.4	97.9	24.0	0.189
GT-12	GT-12-B-05	94.4	26.0	94.1	25.4	0.261
GT-13	GT-13-B-05	94.1	25.4	90.6	26.3	0.147
GT-14	GT-14-B-05	114.7	16.0	114.2	15.5	0.154
GT-15	GT-15-B-05	100.4	23.4	99.5	22.2	0.389

Notes:

a Sample retested for laboratory quality control.

b Field duplicate sample.

c Dry density of sample prepared for permeability test.

d Moisture content of sample prepared for permeability test.

A secondary objective of the soil gas survey was to obtain data on potential releases of VOCs from the landfill when existing vegetation and surface debris are removed prior to installing the new cover. PRC will use this data in developing a health and safety plan to be followed during construction of the remedy. To meet this objective, PRC measured VOC and formaldehyde concentrations in gases 2 to 3 feet below the landfill surface.

As outlined in the technical memorandum (TM) for soil gas sampling (PRC, 1990d), PRC collected soil gas samples from 40 locations within a 148-square grid laid out on the surface of Bowers Landfill. This sampling strategy was based on U.S. EPA guidance for measuring gaseous emission rates from land surfaces (U.S. EPA, 1986a) and took into account both the size of the landfill and RI sampling results, which did not indicate any "hot spots" of contamination on the landfill surface. PRC used random numbers generated by a hand calculator to select the 40 grid squares to be sampled.

Within each grid square, PRC selected a sampling location free of surface debris. To collect the samples, PRC drove a soil gas sampling probe 2 to 3 feet into the landfill. PRC then purged the probe by withdrawing approximately six to eight times the volume of the sampling system. When purging was completed, PRC collected soil gas samples directly into 3-liter tedlar bags in accordance with the procedures described in the TM and QAPjP.

PRC analyzed all soil gas samples in an on-site trailer, using portable instruments to measure methane, VOCs, and formaldehyde concentrations. Methane concentrations were analyzed using a Foxboro 128 Organic Vapor Analyzer (OVA) or an MSA Gascope Model 60 Combustible Gas Indicator (Gascope). VOC concentrations were also measured using the Foxboro OVA and MSA Gascope. PRC analyzed formaldehyde concentrations in soil gas samples using a Dräger Gas Detector equipped with "Formaldehyde 0.002" tubes. Analytical procedures are described in greater detail in both the TM and QAPjP.

Methane concentrations for all soil gas samples are listed in Table 3-2. These concentrations ranged from not detected (ND) to 57 percent. Of the 40 grid squares sampled, 9 had methane concentrations of 6.5 percent or higher, while 27 had methane concentrations of 110 ppm or less. The remaining four samples had methane concentrations between 350 and 6,960 ppm. Figure 3-2 shows the distribution of methane concentrations over the surface of Bowers Landfill. Symbols are included only in those grid squares sampled -- the absence of a symbol indicates that a grid square was not sampled. The figure indicates that highest methane concentrations are clustered near the southern end of the landfill -- Areas A and B on Figure 3-2. The average methane concentrations in these areas were 11.5 and 15.1 percent, respectively. No readings above 1 percent were measured on the northern portion of the landfill -- Areas C,

TABLE 3-2

BOWERS LANDFILL SOIL GAS CONCENTRATIONS OF METHANE AND VOCS

Sample Number	Grid Location	Date Sampled	Code[a]	Methane Concentration[b]	VOC Concentration[b]
BL-SG-004-01	4	07/10		21 %	ND
BL-SG-005-01	5	07/10		20 %	ND[c]
BL-SG-006-01	6	07/10		350 ppm[c]	ND
BL-SG-012-01	12	07/10		22 %	ND
BL-SG-015-01	15	07/10		100 ppm[c]	ND[c]
BL-SG-020-01	20	07/10		ND[c]	ND[c]
BL-SG-021-01	21	07/11		100 ppm[c]	ND[c]
BL-SG-024-01	24	07/11		6.5 %	1%
BL-SG-026-01	26	07/11		19 %	ND
BL-SG-027-01	27	07/11		47 %	ND
BL-SG-174-01	174	07/12	D27	30 %	4%
BL-SG-030-01	30	07/11		ND	ND
BL-SG-031-01	31	07/11		47 %	ND
BL-SG-180-01	180	07/12	D31	3.5%[c]	ND
BL-SG-031R-01	31	07/13	RD31	57%	ND
BL-SG-031RW-01	31	07/13	RD31	25%	ND
BL-SG-034-01	34	07/11		ND	ND
BL-SG-037-01	37	07/11		36 %	ND
BL-SG-160-01	160	07/11	D37	36 %	ND
BL-SG-042-01	42	07/11		110 ppm	ND
BL-SG-045-01	45	07/11		95 ppm	5 ppm
BL-SG-048-01	48	07/11		ND	ND
BL-SG-057-01	57	07/11		27 %	ND
BL-SG-063-01	63	07/11		22 ppm	1 ppm
BL-SG-070-01	70	07/12		11 ppm	ND
BL-SG-073-01	73	07/12		18 ppm	ND
BL-SG-078-01	78	07/12		11 ppm	ND
BL-SG-080-01	80	07/12		3 ppm	ND
BL-SG-081-01	81	07/12		3 ppm	ND
BL-SG-170-01	170	07/12	D81	3 ppm	ND
BL-SG-082-01	82	07/12		820 ppm	ND
BL-SG-085-01	85	07/12		ND[d]	ND[d]
BL-SG-092-01	92	07/12		ND[d]	ND[d]
BL-SG-100-01	100	07/12		11 ppm[d]	ND[d]
BL-SG-103-01	103	07/12		8 ppm[d]	6 ppm[d]
BL-SG-104-01	104	07/12		4 ppm[d]	ND[d]
BL-SG-106-01	106	07/13		ND[d]	ND[d]
BL-SG-110-01	110	07/13		6960 ppm[d]	100 ppm[d]
BL-SG-119-01	119	07/13		ND[d]	ND[d]
BL-SG-124-01	124	07/13		ND[d]	ND[d]
BL-SG-129-01	129	07/13		ND[d]	ND[d]
BL-SG-132-01	132	07/13		ND[d]	ND[d]
BL-SG-135-01	135	07/13		63 ppm[d]	3 ppm[d]
BL-SG-140-01	140	07/13		ND[d]	ND[d]
BL-SG-142-01	142	07/13		ND[d]	ND[d]
BL-SG-145-01	145	07/13		1074 ppm[d]	100 ppm[d]
BL-SG-030FB-01	30	07/11	FB	ND	ND
BL-SG-078FB-01	78	07/12	FB	11 ppm	ND
BL-SG-103FB-01	103	07/12	FB	ND[d]	ND[d]
BL-SG-106FB-01	106	07/13	FB	ND[d]	ND[d]
BL-SG-140FB-01	140	07/13	FB	ND[d]	ND[d]

TABLE 3-2 (Continued)

BOWERS LANDFILL
SOIL GAS CONCENTRATIONS
OF METHANE AND VOCS

Notes:

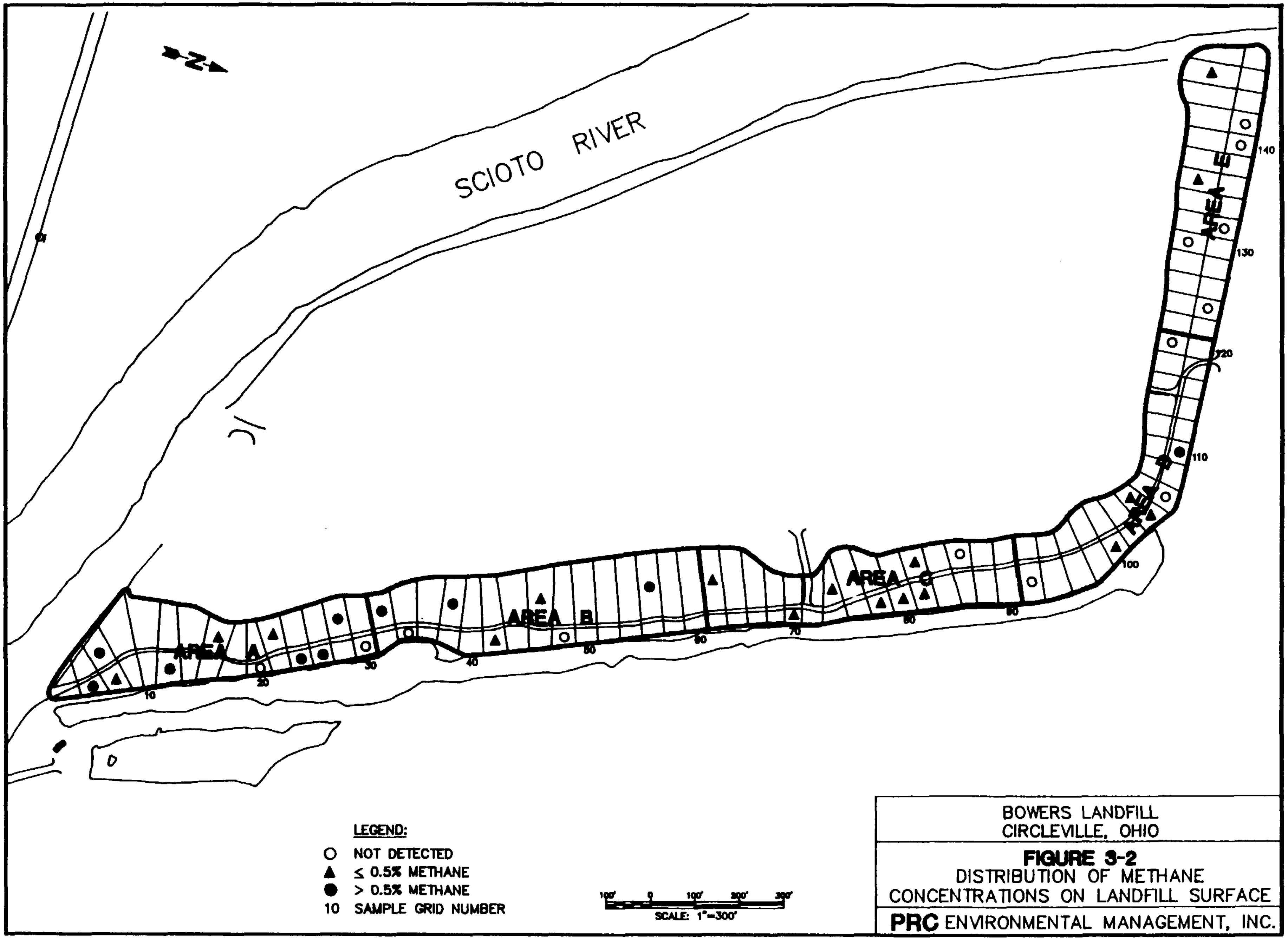
a The following codes are used:
D indicates a duplicate sample collected at the grid location shown by the number following the D.
RD indicates a repeat duplicate sample, a second or third duplicate collected at a sampling location.
FB indicates a field blank sample.

b ND indicates that no methane or VOCs were detected.

c Sample was reanalysed on the day after collection using the OVA equipped with a 10:1 dilutor; results for the reanalysis are reported. All other samples were analysed within 5 hours of collection.

d Reported concentration was adjusted for high background readings in on-site trailer.

e Results for this sample were not included when calculating summary statistics, as explained in Section 5.2 of the soil gas TM (PRC, 1990d).



BOWERS LANDFILL
CIRCLEVILLE, OHIO

FIGURE 3-2
DISTRIBUTION OF METHANE
CONCENTRATIONS ON LANDFILL SURFACE

PRC ENVIRONMENTAL MANAGEMENT, INC.

D, and E. The average methane concentrations in these areas ranged from 0.03 to 0.26 percent. Analyses presented in the TM indicate that this distribution of high methane concentrations is statistically significant.

These results indicate that portions of Bowers Landfill still contain high levels of methane below the surface. The high methane concentrations were unexpected, given the age of the landfill and the highly permeable cover that is now in place. Descriptions of landfill operations in earlier reports on Bowers Landfill indicate that waste disposal began at the northern end of the landfill and proceeded to the southern end. The fact that wastes in the southern end of the landfill were disposed of more recently may partially explain the higher methane levels in this area. However, other factors, such as variations in waste composition over the length of the landfill, may also have affected observed methane concentrations.

The high methane concentrations indicate that a gas collection and venting system should be included in the remedial design for the landfill cover. Section 8.0 describes this system in greater detail.

VOC concentrations for all soil gas samples are also listed in Table 3-2. VOCs were detected at only 8 of 40 grid locations sampled and did not show any pattern of distribution over the landfill. Concentrations exceeded 100 ppm at only four grid locations. These results generally agree with sampling data from the RI, which showed low or negligible VOC concentrations in air, soil, surface water, ground-water, and sediment samples. Formaldehyde was not detected in any of the soil gas samples.

These results suggest that air emissions of VOCs during construction of the remedial design are not a major concern for on-site workers or off-site residents near the landfill. Nevertheless, a limited air monitoring program should be conducted during construction to confirm this conclusion.

3.3 GROUND-WATER AND SURFACE WATER SAMPLING

During the week of August 6 through 10, 1990, PRC sampled 18 of 20 monitoring wells at Bowers Landfill and 2 surface water locations in the drainage ditch east of the landfill. (Two wells could not be sampled because of damage to the casings.) PRC also measured water levels in each monitoring well. The major objective of this activity was to obtain current data on contaminant concentrations in these media, because the last complete sampling round was conducted in May 1987. This information may be useful in selecting wells to be included as part of a long-term ground-water monitoring program for the landfill. In addition, water level data and ground-water flow patterns will help locate three new well clusters to be installed as part of the remedial action.

PRC has received only partial results of these samples to date. However, these results do not suggest any significant changes in ground-water contaminant concentrations from the 1987 data. PRC will complete and submit a TM for ground-water and surface water sampling after all results have been received.

4.0 ENVIRONMENTAL IMPACTS

The environmental impacts of the remedial construction include changes to the floodplain and creation of a wetland. These impacts are evaluated below.

4.1 FLOODPLAIN EVALUATION

The Bowers Landfill is located in the 100-year floodplain of the Scioto River. The PRC design team reviewed the requirements for floodplain protection and construction in a floodplain. The Bowers Landfill cap design will meet the two applicable or relevant and appropriate federal and state requirements (ARAR), associated with floodplain protection, construction, operation, and maintenance, that are indicated in the ROD.

The first floodplain ARAR is the U.S. EPA requirement described in 40 CFR 6, Appendix A, a Statement of Procedures on Floodplain Management and Wetlands Protection. This ARAR requires that construction in floodplains be done in such a manner as to minimize harm to the floodplain. Executive Order 11988, "Floodplain Management" dated May 24, 1977, requires federal agencies to evaluate the potential effects of actions they might take in a floodplain and to avoid adversely impacting floodplains wherever possible. The ROD states that construction within the Scioto River floodplain is unavoidable in implementing a remedial action for Bowers Landfill. The cap construction activities will have a negligible effect on the 100-year floodplain.

The second floodplain ARAR addressed in this report is the RCRA requirements for construction, operation, and maintenance of hazardous waste landfills in 100-year floodplains. The cover will be designed to prevent washout of any hazardous wastes by a 100-year flood, as required by RCRA General Facility Standards in 40 CFR 264.18. The requirements for existing landfills include demonstrating to the Regional Administrator's satisfaction that no adverse effects on human health or the environment will result if washout occurs, considering: (1) the volume and physical and chemical characteristics of the waste in the facility and (2) the concentration of hazardous constituents that would potentially affect surface waters as a result of washout. During construction of the cap, surface water contamination will be minimized and periodically monitored. Waste in the facility will be contained by the cap designed to prevent washout. Construction activities will have no adverse effects on human health or the environment and no impacts on surface water and sediment. Based on the geotechnical study, the quality and quantity of clay in the fields west and north of the landfill is suitable for the clay cap material, and the fields can provide all the soil necessary to cover the landfill. Geotechnical studies conducted in the preliminary design stage of this remedial alternative determined that the cover materials would be capable of protecting the landfill from damage due to flooding. Section 8 of this report, Erosion Protection and Drainage Improvements, describes the slope stability of the cover materials, the effects these flood waters may have on the landfill, and how the cap design will minimize these effects.

4.2 WETLAND CREATION

The excavation of the clay from the west field will provide areas that would be under water due to flooding and the opportunity for a wetland area to develop. Creation of a wetland will eliminate land use for farming as discussed in Section 9.2. This activity will be conducted based on recommendations from the Ohio Division of Wildlife. The excavated area will be graded to provide waterways and retention ponds. A contour drawing for the wetland area will be prepared for the prefinal design. This drawing will also indicate species of vegetation targeted for that area.

5.0 SURFACE DEBRIS MANAGEMENT AND VEGETATION REMOVAL

Prior to construction of the landfill cap, the surface debris and vegetation must be removed. This section describes removal procedures for material on the landfill and for debris on the east side of the drainage ditch that runs along the landfill.

5.1 LANDFILL VEGETATION AND SURFACE DEBRIS

All vegetation such as trees, brush, and weeds will be cleared before the surface debris is removed. The medium to light trees and the heavy brush will be cut down, chipped, and stockpiled in the west field. This stockpile will be secured to prevent washout by flooding. The tree stumps will be ground down in place, and the chips will be removed as required. Weeds and other ground cover will be cut and stockpiled with the wood chips. The stockpiled vegetation can later be mixed with the topsoil that will be used for the vegetative cover. Thus, the vegetation will be used to fertilize the topsoil, speed vegetative growth, and minimize erosion loss.

One potential disadvantage to this procedure is that contaminants, if present in the vegetation, may be transferred to the topsoil. However, PRC's review of (1) the contaminants present at the site and (2) the uptake of these contaminants by plants indicates that this is unlikely. Based on this review, PRC believes that the vegetation removed from the landfill can be considered non hazardous. In general, there is little evidence that terrestrial plants take up these contaminants from soil in concentrations that would pose a risk to users of the plants (NLM, 1990). Any such uptake would be through the roots. In fact, most toxicity from contaminated plants are due to the application of toxicants through the air onto the surface of the leaves, stems, and other aboveground parts (Clarke and Clarke, 1975). This type of deposition is not considered significant for the Bowers Landfill site because the contaminants are in the soil and ground water, and only fugitive dust from wind or vehicle traffic across the landfill could generate this condition.

A few metals are known to be taken up by plants in quantities that are dangerous to livestock. The best known are cadmium, molybdenum, and selenium (Clarke and Clarke, 1975; Carson and others, 1986). However, none of these metals is a significant contaminant at Bowers Landfill. Specific studies of lead have found no significant uptake (Clarke and Clarke, 1975; NLM, 1990). Lead is a normal constituent of plants, with levels of 0.1 to 1.0 mg/kg in cereals, 1.0 mg/kg in pasture grass, and 2.5 mg/kg in the leaves and twigs of woody plants.

If vegetation remains at Bowers Landfill that is not chipped and used for the cover, it will be burned. The removal cost for the portion of the vegetation burned would be reduced by approximately 40 percent. Burning appears to be feasible according to Ohio State Air Laws, Chapter 3745-19-04. Bowers Landfill meets the definition of an unrestricted area -- it is located more than 1 mile beyond a municipal corporation having a population of 10,000 persons or more. Open burning of land-clearing waste is allowed in unrestricted areas with written permission from OEPA (and an air permit, if required), provided that the following conditions are observed: (1) the fire is set only when atmospheric conditions will readily dissipate contaminants; (2) the fire does not create a visibility hazard on roadways, railroad tracks, or air fields; (3) the fire is located at a point on the premises no less than 1,000 feet from any inhabited building not located on said premises; and (4) a device or method determined by OEPA to be effective is used to curtail the release of air contaminants. These conditions could be met at Bowers Landfill if the fire is burning at a high enough temperature and excess oxygen is provided to reduce smoke. The fire would be burned at a reasonable distance from inhabited buildings east and south of the landfill.

The surface debris such as demolition debris, large appliances, tires, auto and truck parts, will be removed, decontaminated, transported, and disposed of off-site. The debris may be decontaminated with a steam cleaner or high pressure water. The debris will be considered nonhazardous after cleaning and will be disposed of at an approved landfill. The decontamination wastewater will be collected, analyzed, and disposed of properly.

Some of the surface debris and vegetation removal tasks will be done concurrently because the debris may be in the way of the clearing operation.

5.2 DEBRIS AT THE SITE ENTRANCE AND IN THE BERM

During construction of a decontamination pad prior to the field investigation activities, trash was uncovered between the southern end of the landfill and the landfill entrance. The trash consists of plastic-wrap material and other waste. Based on discussions with U.S. EPA and OEPA, this waste will be removed and placed on the landfill surface before grading. The entrance area will then be covered with clean fill and graded. The remedial action health and safety plan (Section 14.0) will include appropriate contingencies to be followed in the event that this area contains potentially hazardous materials such as buried drums.

During the investigation of the berm at the southwest end of the landfill, some trash and construction debris were found, as detailed in Section 4.2 of the Geotechnical Investigation Results TM (PRC, 1990d). Based on discussions with U.S. EPA and OEPA, the berm materials will be removed for ease of construction. The materials will be placed on the landfill surface before grading. The berm area will be backfilled with clean soil and graded.

The clean material required to fill and grade the site entrance and berm areas is estimated to be approximately 40,000 cubic yards.

5.3 SURFACE DEBRIS ON THE EAST SIDE OF THE EXISTING DRAINAGE DITCH

Surface debris also lies on a hillside on the east side of the existing drainage ditch. Removal of this debris will be included as part of the remedial design. The debris densely covers an area running along approximately 400 feet of the southern section of the drainage ditch and is scattered along the northern portion of the drainage ditch. The area east of the drainage ditch was not investigated in detail during the RI and is not specifically mentioned in the ROD. However, some of the debris may be associated with landfilling activities. The debris consists of the same types of items as discussed in Section 5.1.

The debris will be removed from this area, and transported and disposed of at a suitable landfill. The two options for off-site disposal of the surface debris include (1) a landfill that accepts construction debris and (2) a sanitary landfill (which would increase the disposal cost). Alternatively, some debris could be placed on the Bowers Landfill surface if the debris will not cause settlement problems.Metal debris from this area could be salvaged for scrap metal. If required, the existing slope will be regraded, dressed, and seeded.

6.0 GAS VENTING SYSTEM

During the soil gas investigation, methane gas was identified in the southern section of the landfill as described in Section 3.2 of this report. At one sampling location, 57 percent methane was detected in the sample. Based on the sampling results, PRC has concluded that methane gas is still being generated within the landfill. To prevent build-up of the methane or any other gas within the landfill, a gas venting system will be installed immediately below the clay cover.

Although methane gas was detected primarily within the southern half of the landfill, the venting system will be installed throughout the length of the landfill. This will be done primarily as a precautionary measure because of the unpredictable nature of methane gas production. The gas venting system will consist of a 6-inch-diameter, high density polyethylene perforated piping (header) installed horizontally along the center line of the landfill. Six-inch diameter vent risers with goose necks and bird screens will be placed approximately every 500 feet along the landfill center line. The header and risers will be installed within the grading layer (see Drawings, Section 15.0, Figure 15-4). A gravel bed will be placed around the header. Any gas generated by the landfill will rise into the grading layer under the clay cover and migrate horizontally due to the porous nature of the grading layer. The gas will flow through the header and be released through the vents into the atmosphere. If required, an Ohio air permit will be obtained for these vents.

7.0 COVER DESIGN

As required by the ROD, the cover system for the Bowers Landfill will be developed to:

- Minimize risk to public health and environment from direct contact with contaminated material.
- Minimize the migration of liquids through the closed landfill.
- Minimize maintenance of the landfill site.
- Promote drainage and minimize erosion of the cover.
- Provide a maximum permeability of 1 x 10-7 cm/sec.

The following sections describe the design of the cover system.

7.1 LITERATURE REVIEW

PRC reviewed pertinent data concerning the design of covers for old landfills in appropriate regulatory references and U.S. EPA guidance documents. The performance standards outlined in Subtitle C of the Resource Conservation and Recovery Act (RCRA) were examined. In addition, the following U.S. EPA documents were reviewed:

- Evaluating Cover Systems for Solid and Hazardous Waste Landfills (U.S. EPA, 1980)
- Covers for Uncontrolled Hazardous Waste Sites (U.S. EPA, 1985)
- Final Covers on Hazardous Waste Landfills and Surface Impoundments (U.S. EPA, 1989b)
- Requirements for Hazardous Waste Landfill Design, Construction, and Closure (U.S. EPA, 1989c)
- Seminars -- Design and Construction of RCRA/CERCLA Final Covers (U.S. EPA, 1990)

The RI and FS reports were reviewed to evaluate the site characteristics and the existing condition of the landfill cover. A literature search was also performed to determine specific parameters required for the cover design. These parameters included hydrogeologic characteristics such as precipitation, runoff rates, average velocity of the Scioto River, and flood levels. Soil Survey of Pickaway County, Ohio (USDA, 1980), and Water Resources Data, Ohio (USGS, 1989) were used as references in the design process.

7.2 COVER SYSTEM

As described in the ROD, the two main components of the cover system are a 2-foot-thick clay layer with a maximum permeability of 1×10^{-7} cm/sec, and a minimum 2-foot-thick soil cover layer with a 6-inch vegetative layer. A third component, consisting of a 1-foot-thick granular soil grading layer, is required to provide a uniform surface for placing the clay layer. This layer will also serve as the gas venting layer. Details of these components and other elements of the cover design are described in the following subsections.

7.2.1 Grading and Gas Venting Layer

The surface of the existing landfill is uneven and the side slopes vary from 1:1 to 3:1. A grading layer consisting of granular (sandy) material will be installed to provide proper side slopes and an even surface to receive a low permeability clay layer. The grading layer will also serve as the gas venting layer, which is required based on the soil gas investigation results. The granular material will be used on the side slopes of the landfill and will have a minimum thickness of 8 inches to obtain a 3:1 slope. On the top, a minimum thickness of 12 inches will be placed at a 5 percent slope to provide proper drainage. The granular material will be obtained from a local quarry, or sandy soil will be obtained from the west field.

At the southern end of the landfill (near the entrance of the landfill and on the southwestern berm), existing trash at or near the surface will be removed, placed on the landfill, and the areas regraded.

The quantity of the granular material required for the grading layer, fill material at the site entrance, and the berm is estimated to be approximately 40,000 cubic yards.

7.2.2 Low Permeability Clay Cover

A 2-foot-thick clay cover with a maximum permeability of 1×10^{-7} cm/sec will be constructed on top of the grading layer. During the geotechnical investigation, it was determined that 65 percent of the soil samples collected in the west and north fields met this permeability requirement (see Section 3.1).

On the basis of the proposed typical cross-section (see Section 15, Figure 15-1) and the length of the landfill (scaled from a topography map), the volume of clay required is estimated to be 60,000 cubic yards. The volume of clay available in the west and north fields that could meet the permeability requirement is estimated to be 1,200,000 cubic yards. This estimate is based on the depth of the clay layers from the RI, the measured areas of the west and north fields, and the location of samples meeting the permeability requirement (see Figure 3-1 and Table 3-1).

The clayey materials from the field areas will be selectively used during the construction of the clay cover. The materials will be excavated and placed on the top and sides of the grading layer, in 8- to 9-inch loose lifts and compacted with a sheeps-foot roller to 6 inches having 95 percent of the standard proctor density. Additional lifts will be placed and compacted using the same method to obtain proper bonding between the previous and the new lifts. Four lifts will be placed and compacted to achieve a uniform 2-foot-thick clay cover.

7.2.3 Topsoil Cover

A 3-foot-thick topsoil cover will be constructed on the top and sides of the low permeability clay cover. This cover will consist of lightly compacted clayey material obtained from the west and north fields adjacent to the landfill. The 3-foot thickness is required to protect the low permeability clay cover from freezing and thawing during the winter months, which can damage the clay layer. For the Ohio area, the average frost protection depth shown in the guidance document, Final Covers on Hazardous Waste Sites (U.S. EPA, 1989b), is 20 inches. However, the recommended values for utility lines and the building foundations are 4 feet and 3 feet respectively (Alvater, 1990). Therefore, a 3-foot frost protection depth is considered adequate for the impervious clay layer underlying a compacted topsoil layer.

The topsoil cover materials will be excavated from the west and north fields, placed in 12-inch loose lifts, and graded smooth with a bulldozer. This material will be similar to that used for the low permeability clay cover, but not as compacted. Since this is the outermost layer (excluding the 6-inch vegetative cover), the slope stability was calculated based on the properties of the topsoil as worst case (see Section 8.0). A slope of 3:1 is estimated, with a safety factor of 2. The volume of clay material required for the topsoil cover is estimated to be approximately 90,000 cubic yards.

7.2.4 Vegetative Cover

A 6-inch vegetative cover will be constructed on the top and sides of the 3-foot topsoil cover. The purpose of the vegetative cover is to promote the growth of grass. The grass will reduce soil erosion on the top and sides of the landfill caused by wind, rain, and flooding. The grass will further stabilize the side slopes of the landfill and promote evapotranspiration.

The west field adjacent to the landfill has been used for agricultural purposes. A variety of crops have been cultivated in this field. Soybean crops were observed in the northern part of the field during the geotechnical investigation. The topsoil layer of the field was visually classified during the sampling activities and varied from 10 to 16 inches deep. This material will be the most suitable for the vegetative cover. Wood chips from the trees and brush cleared from the landfill surface may be mixed with the soil to provide organic material and break up the soil.

Additionally, a polypropylene mesh will be placed on the side slopes before placing the vegetative layer. This mesh will serve two purposes: (1) it will prevent grass, seeds, and plants from washing out during rains and floods, promoting vegetation growth, and (2) it will reinforce side slopes, reducing erosion due to wind, rain, and flooding.

7.2.5 Settlement

One element of the cap design to be addressed is the settlement of the landfill. Bowers Landfill is a low-rise landfill with an average depth of 10 feet, including the present soil cover. The landfilling operation began in 1958 and ended around 1968. Most of the significant settlement should have taken place during the time after landfilling operations ceased. A contour map drawn from an aerial photograph of May 1984, showing the landfill surface elevations (included in the RI), was compared with the topographic map developed in May 1990 as part of the RD. This comparison did not show any measurable settlement. Also, site observations during field activities did not indicate any unusual signs of recent settlement.

When the landfill cover is constructed, there may be some long-term settlement due to the weight of the soils added. However, given the shallow depth of the landfill, significant additional settlement is not anticipated.

During the operation and maintenance of the landfill, the top surface of the soil will be checked for settlement damage. Appropriate action will be taken to remedy any problems that are found.

8.0 EROSION PROTECTION AND DRAINAGE IMPROVEMENTS

One component of the remedial design as described in the ROD consists of erosion protection and drainage improvement. Various factors considered in designing erosion protection and drainage improvements are: (1) slope stability; (2) sheet piling; (3) vegetation planting; (4) soil loss estimate; (5) surface drainage; (6) surface water infiltration; and (7) drainage ditch dewatering. These components are discussed in the following sections.

8.1 SLOPE STABILITY

The side slopes of the landfill cover will be designed to stabilize the landfill. The cover system will be constructed of the following four layers: (1) grading layer; (2) a low permeability clay layer; (3) a topsoil layer; and (4) a vegetation layer. The slope stability of each layer is addressed in the following paragraphs.

The grading layer will consist of granular (sandy) materials obtained from a local quarry. The angle of internal friction for granular material can be conservatively estimated as equal to the angle of repose or about 30 degrees. A slope of 3:1 is flatter than 30 degrees. Additionally, the grading layer will be confined by the weights of compacted clay and topsoil layers. Therefore, the slope will be stable, and calculations are not required for the grading layer.

The low permeability clay cover will consist of the clayey materials obtained from the west and north fields adjacent to the landfill. These materials will be compacted to 95 percent of the standard proctor density and will have high shear strength values. This layer will be confined by the 3-foot-thick topsoil layer, which will consist of the same clayey materials but not as compacted. Also, the height of the clay layer will be 3 feet less than the topsoil layer. Therefore, the slope stability will not be controlled by the properties of the clay layer.

The topsoil layer will also be constructed of the clayey material from the west and north fields. During the geotechnical investigation, bulk soil samples were tested to determine their physical properties and strength characteristics. Unconfined compressive strength tests (ASTM, 1985) were conducted on soil samples compacted to 100 percent of standard proctor density at optimum moisture content. Most of these samples were collected at a depth of 5 feet. Since there is more than adequate amount of clayey material available for the impervious clay layer, the same material can be used for the topsoil cover. This material, when used for topsoil cover, will be placed in 12-inch lifts and graded by using a bulldozer on the top and the side slopes to achieve 90 percent compaction. The slope stability calculations are based on a conservative cohesion value of $C' = 450$ psf (~0.3 x 1,600, the lowest value obtained from the geotechnical report), and an internal angle of friction p = 15 degrees for calculating stability of side slopes. These values are based on the standard engineering practice for the material to be used, and recommendations by Paul de Verteuil (1990) of MdV, who reviewed the results of the unconfined compression strength test on bulk samples (PRC, 1990d).

The slope stability was calculated using Spencer's Method (Winterkorn and Fang, 1975):

$$Ns = \frac{C'}{F\gamma H}$$

$$\text{and } \tan Ø'm = \frac{\tan Ø'}{F}$$

where:

Ns	=	Stability factor
C'	=	Effective cohesion = 450 psf
γ	=	Unit weight of soil = 125 pcf (average values of compacted samples)
F	=	Factor of Safety = 2
H	=	Height of slope = 15.5 feet (current height at the landfill edge + grading layer thickness + clay cover thickness + topsoil cover thickness = 9.5 + 1 + 2 + 3)
Ø'm	=	Mobilized angle of shear resistance
Ø'	=	Effective Friction Angle = 15°

$$Ns = \frac{450}{2 \times 125 \times 15.5} = 0.116$$

$$\tan Ø'm = \frac{\tan 15^\circ}{2} = 0.134$$

$$Ø'm = 7.63^\circ$$

By extrapolating stability charts for pore pressure ratio ru = 0.5 (worst case), the slope required is calculated to be less than 2:1; therefore, a 3:1 slope will be used. Additional detailed calculations will be made during the pre-final design.

Slope stability for the 6-inch-thick vegetative layer will be achieved by seeding and promoting grass growth on the side slope. However, since the landfill site is repeatedly flooded, additional protection is recommended for the side slopes. A polypropylene mesh will be placed on the side slopes of the 3-foot topsoil cover, and then the 6-inch vegetative cover will be placed and graded by a bulldozer. The mesh reinforces the vegetative layer, and keeps the seeds and roots from washing out during rain and floods, promoting the grass growth, and thus providing additional erosion protection.

8.2 SHEET PILING

As discussed in the FS, the landfill axis runs perpendicular to the floodwaters at the northern end of the landfill. During flooding, water may be diverted around the landfill, causing scouring action at the northwest corner of the landfill. Similarly, scouring may occur at the south end of the landfill. At both these locations, either sheet piles or riprap is required for the erosion protection. 2

If riprap is used, it must extend substantially into the river at both ends of the landfill. Therefore, riprap is not considered practical. Steel sheet piles are suitable for the specific site conditions and will provide permanent protection against the scouring action.

Sheet piles consist of Z-shaped structural steel members approximately 18 inches wide and 12 inches deep, with interlocking shapes at the edges. These members are individually driven into the ground with pile driving equipment and interlocked to provide a continuous impervious barrier. When properly designed, these members can withstand lateral pressures from either side.

Sheet piles will be designed for the maximum lateral soil pressure on the landfill side and the lowest water level pressure on the river side. Sheet piles will be terminated 3 feet above the final cover elevation along the river to provide a safety barrier.

Sheet piles for the northwest end of the landfill will be approximately 40 feet high by 350 feet long, and for the south end, 60 feet high by 470 feet long. The approximate placement of sheet piles is shown on Figures 8-1 and 8-2. The total quantity of sheet piles (assuming 38 pounds per square foot) is estimated to be 800 tons. The actual size and length of the sheet piles will be designed and detailed during the pre-final design.

FIGURE 8-1
SHEET PILES AT NORTHWEST END OF LANDFILL

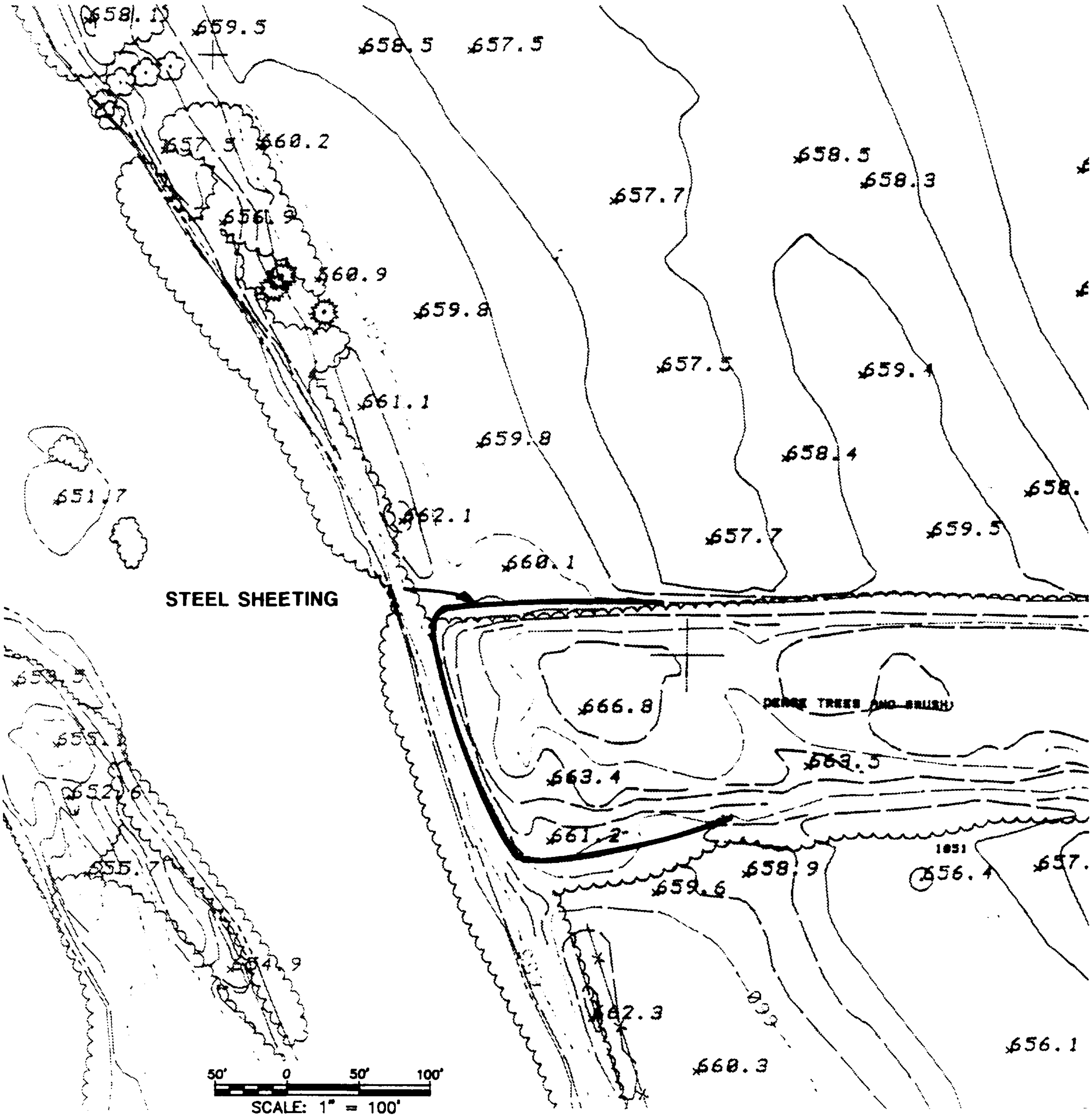
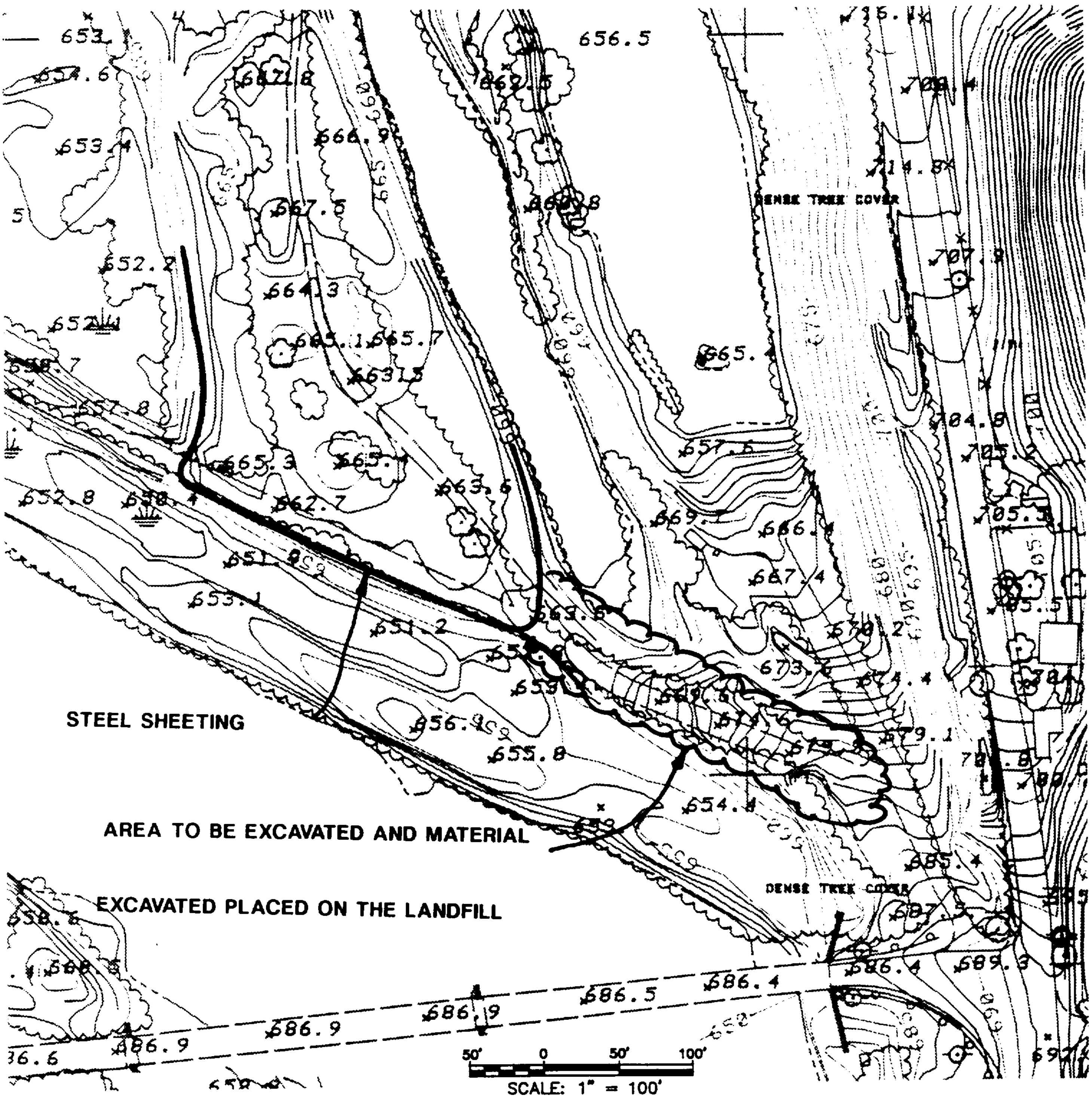


FIGURE 8-2
SHEET PILES AT SOUTH END OF LANDFILL



8.3 VEGETATION PLANTING

The vegetation planting will consist of grass species to provide a thick cover and limit long-term erosion. The species will be selected for their hardiness and low maintenance requirements. The grass will be seeded and fertilized as soon as practical after placement of the vegetative cover. Seeding will be done by hydroseeding methods.

A variety of plants will be selected and planted in the west field wetland. The species will be selected based on recommendations by the Ohio Division of Wildlife. The cost of planting has not been included in the cost estimate.

8.4 SOIL LOSS ESTIMATE

One aspect of erosion protection is to estimate soil loss and to determine if it is significant. Soil loss is caused by rainwater running down the slope of the landfill, carrying surface soil particles with it. This is called sheet and rill erosion.

Soil loss can be estimated by using the universal soil loss equation, which is an empirical method. The equation uses rainfall data, soil characteristics, slope length, and type of vegetation to compute soil loss.

The general form of the universal soil loss equation is:

$A = R \times K \times LS \times C \times P$ (Goldman, Jackson, and Bursztynsky, 1986)

where:

A = soil loss, tons/(acre)(year)

R = rainfall erosion index, in 100 feet tons/acre x inch/hour
= 150 for Columbus, Ohio

K = soil erodibility factor, tons/acre per unit of R
= 0.37 (USDA, 1980)

LS = Slope length and steepness factor, dimensionless
= 5.95 for 3:1 side slope for 40-foot slope length
= 0.43 for 20:1 (5 percent) top slope for 65-foot slope length

C = vegetative cover factor, dimensionless
= 0.01 for established grass cover

P = erosion control practice factor
= 1.3 for compacted smooth soil surface

$$A = 150 \times 0.37 \times 5.96 \times 0.01 \times 1.3 = 4.3 \text{ tons/(acre)(year)}$$

assuming soil weight = 125 pounds/cubic foot

$$\text{Soil loss} = \frac{4.3 \times 2{,}000}{125 \times 43{,}560} = 0.0016 \text{ feet/year} = 0.02 \text{ inch/year}$$

for 3:1 side slope.

Similarly, soil loss is 0.001 inch/year for 20:1 (5 percent) top slope.

From the above calculations, it is concluded that the effects of the soil erosion should be negligible.

8.5 SURFACE DRAINAGE

Another aspect of erosion protection is surface water drainage. Bowers Landfill is a long, narrow landfill with a maximum width of approximately 125 feet. With a top cover slope of 5 percent, the difference in elevation from the center to the top edge width will be approximately 3.25 feet. The sides will have a 3:1 slope for approximately 40 feet to the field on the west and the ditch on the east. The precipitation will quickly drain to the west field and to the east drainage ditch because of the short travel distance (approximately 100 feet on either side of the center of landfill). Therefore, surface drainage will not cause any significant erosion problems. The new cover will substantially improve the surface drainage from the present condition.

8.6 SURFACE WATER INFILTRATION

The amount of surface water passing through the new cover will be calculated during the pre-final design using the Hydrologic Evaluation of Landfill Performance (HELP) computer software program, and hydrological and meteorological data for the Circleville region. HELP allows simulation of climatic conditions, such as precipitation, evaporation due to temperature, and evapotranspiration due to the type of vegetation. It uses thicknesses of various soil component layers and their corresponding permeability values, and computes the amount of water infiltrating through the various soil layers. This computation will help evaluate the protectiveness provided by the new cover by comparing the result to the values computed for the existing landfill in the FS.

The accuracy of the results may be limited because of the following reasons:

- The landfill is built as a narrow, low-rise embankment without an impervious bottom layer. This may allow groundwater to rise up through the bottom of the landfill, which may affect the downward infiltration simulated by the HELP model.

- Due to the narrow and shallow feature of the landfill, any rainwater or floodwater on the surface quickly discharges to the west field and the east drainage ditch. In this case, the actual infiltration may be less than computed by the HELP model.

The Bowers Landfill site is located in a 100-year floodplain. During 100-year flood, the maximum water level at the upstream end reaches an elevation of 676.8 feet. Reportedly, the existing landfill is occasionally topped by flood waters. HELP will be used to simulate flood conditions and calculate water infiltration through the landfill.

8.7 DRAINAGE DITCH DEWATERING

The drainage ditch on the east side of the landfill collects water during rains and flooding, and from surface runoff from the landfill. This water does not currently discharge to the Scioto River due to obstructions in the existing pipe. At the present time, standing water up to 5 feet exists in the ditch. One of the tasks under the remedial design is to improve the drainage through the ditch. To accomplish this, the drainage ditch will be: (1) dewatered and (2) regraded to improve drainage.

The water will be pumped through a sediment tank and discharged to the Scioto River. If necessary, a National Pollutant Discharge Elimination System (NPDES) permit will be obtained for discharges to the river. The discharge will be monitored to verify compliance with the Ohio Water Quality Standards listed in OAC 3745-01. The sediment collected in the sediment tank will be removed, dewatered and placed on the existing landfill prior to capping. In addition, sediments remaining in the drainage ditch will be excavated and placed on the landfill after the vegetation and surface debris have been cut and removed from the landfill.

Because of the landfill cap side slope requirements, the existing ditch will be regraded and its invert (top surface) raised. The area will be graded to provide better drainage and eliminate standing water. A 36-inch-diameter concrete pipe culvert will be installed to allow water to drain from the east side of the landfill from the southern end of the ditch into the Scioto River. Headwalls and an apron will be installed at the inlet of the culvert to prevent scouring of the soil around the culvert.

During the field investigation, the existing pipe could not be located. During the construction of the cover, this pipe should be completely encased within the landfill. However, the pipe will be sealed if it is located during the construction.

9.0 INSTITUTIONAL CONTROLS

Institutional controls will be implemented at Bowers Landfill to prevent disturbance of the site after the remedial action has been constructed. Institutional controls include obtaining deed restrictions, securing permanent easements, and restricting site access.

9.1 DEED RESTRICTIONS AND PERMANENT EASEMENTS

PRC will assist U.S. EPA in obtaining deed restrictions to prohibit disturbance of the landfill and to prohibit ground-water extraction in the field west of the landfill. These deed restrictions will be put in place prior to constructing the remedial alternative.

PRC is currently conducting a boundary survey at Bowers Landfill to determine the property lines of the Bowers Estate and the owners of properties adjacent to the landfill. Information from the property survey will help determine if any permanent easements will be required for constructing the landfill cover. If it is determined that the cover will extend onto property not owned by the Bowers Estate, PRC will assist U.S. EPA in securing permanent easements prior to bidding the construction work.

9.2 AGRICULTURAL USE RESTRICTIONS

The field west of the landfill will not be suitable for farming following remedial action construction. Large volumes of clay and top soil will be removed from the west field, lowering its elevation. The field will be inundated with floodwater for a much longer period of time than normal, which will damage any crops and make agricultural use of this field impractical. Agricultural use of the field could also be detrimental to the new landfill cover -- farming activities in the field such as plowing could damage the cover. If required, the deed restrictions described in Section 9.1 could prohibit future agricultural activities.

9.3 SITE ACCESS RESTRICTIONS

During the initial stages of construction, a temporary fence will be installed for security purposes. Also, the landfill site will be permanently fenced, and signs will be posted to restrict public access from the nearby streets. The permanent fence will be a 6-foot-high chain-link fence with three strands of barbed wire at the top. The fence will be installed as early as feasible once the remedial action begins and it will be visible to the public. The fence will start at the bridge on Circleville-Florence Chapel Road, and continue eastward to Island Road. On the east side of the site, the fence will be installed along Island Road. The specific locations of the fence, which will be determined based on the boundary survey results, will be presented in the pre-final design. A 20-foot-wide double-swing gate will be installed at the front entrance to the site.

Fencing the north and west sides of the site is not practical because floodwaters would cause the fence to collapse. The north side of the site is bordered by private property, and the west side is bordered by the Scioto River. Fencing installed along the river by the PRPs in the Spring of 1990 collapsed due to flooding.

In addition to fencing at Bowers Landfill, prominent warning signs will be posted. These signs will notify the public that (1) the area is hazardous due to chemicals in soils and ground water, (2) these chemicals may pose a risk to public health through direct contact with soils and ingestion of ground water, and (3) trespassing is prohibited. These signs will also include the OEPA phone number to call for further information. Signs will be posted at the site entrance gate on Circleville-Florence Chapel Road, and every 200 feet along the fence. Signs will also be posted along the northern boundary of the landfill and along the Scioto River bank as necessary.

10.0 OPERATION AND MAINTENANCE PLAN

The operation and maintenance (O&M) plan for the Bowers Landfill remedial design will include three major components: (1) gas monitoring, (2) ground-water and surface water monitoring, and (3) other O&M activities. These components are described briefly in the following sections. A detailed O&M plan will be included in the pre-final design.

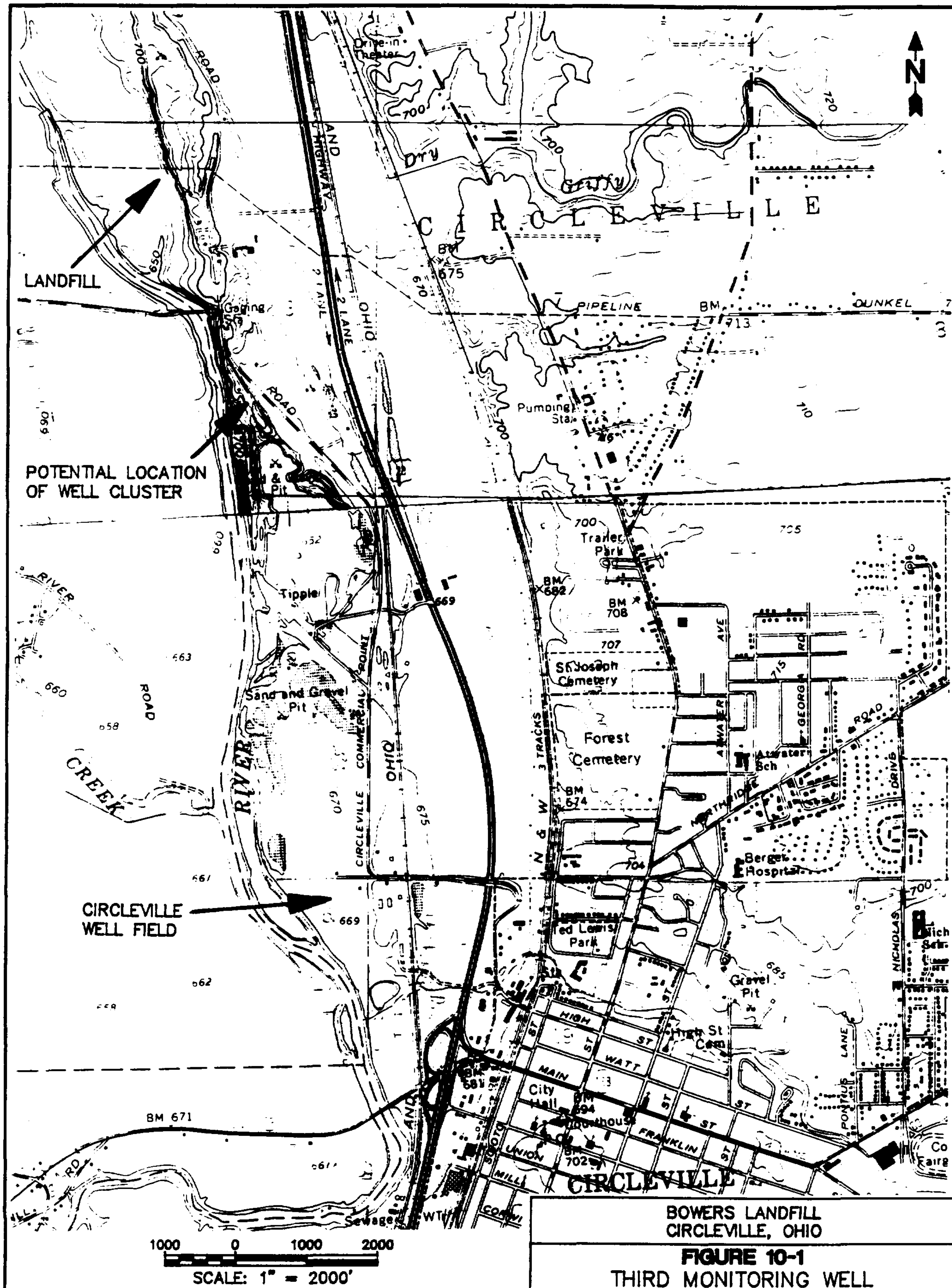
10.1 GAS MONITORING

The methane gas and VOCs at each vent pipe will be monitored quarterly with appropriate survey instruments and the readings recorded. The gas venting system will be inspected quarterly for damaged vent pipes and the bird screens of the gas vents will be checked for obstructions. The pipes and bird screens will be repaired as necessary.

10.2 GROUND-WATER AND SURFACE WATER MONITORING

Three additional well clusters will be installed at Bowers Landfill as part of the remedial action. These wells will be installed to develop a ground-water monitoring program that will adequately detect any future contaminant releases from Bowers Landfill. Each cluster will consist of three wells -- a shallow well located in the upper portion of the saturated alluvial aquifer, an intermediate well located between the water table and the bedrock surface, and a deep well located just above bedrock. These wells will be approximately 25 feet, 35 feet, and 70 feet deep, respectively, based on depths of similar wells in the existing monitoring network. Each well will be constructed of a 2-inch stainless steel pipe inner casing that will be protected by a steel outer casing. As required by the ROD, two clusters will be installed west of the landfill, with one cluster between wells W-5 and W-6 and the second cluster between well W-10 and the northeast corner of the landfill. The third cluster will be installed approximately ½ mile south of the landfill (see Figure 10-1). This cluster will be located across the street from the Pickaway County Engineer Highway Division building, approximately 50 feet west of Island Road. The property is owned by American Aggregates Corporation and is accessible to a drill rig. In addition, the location would be suitable for monitoring the potential movement of ground-water contaminants toward the Circleville well field, approximately 1-½ miles south of the landfill.

Remedial alternative construction will also include repairing and modifying several existing monitoring wells. During RD field investigations, PRC was unable to sample wells W-10 and P-6B because the inner casings had collapsed. These wells will be repaired during construction. Monitoring wells W-5, P-5A, P-5B, W-6, P-6A, P-6B, W-7, and P-7A must also



BOWERS LANDFILL
CIRCLEVILLE, OHIO

FIGURE 10-1
THIRD MONITORING WELL
CLUSTER LOCATION

PRC ENVIRONMENTAL MANAGEMENT, INC.

be modified. These wells are close to the edge of the landfill and would be buried by the cap side slopes. The casings of these wells will be extended above the cap elevation to allow the wells to be included in the ground-water monitoring program.

The ground-water monitoring program will begin after the remedial construction activities have been completed. The basic requirements for the first 4 years of this program are outlined in the ROD. All 29 wells (20 existing wells plus 9 wells to be installed) will be sampled bimonthly during the first year following remedial action construction. Samples collected during the first year will be analyzed for organic chemicals on U.S. EPA's Target Compound List (TCL) and metals on U.S EPA's Target Analyte List (TAL). Results will be used to develop a concentration range for each TCL chemical and TAL metal at each monitoring well location. For years 2 through 4 following the remedial construction, approximately 15 wells will be part of the quarterly ground-water monitoring program. These wells will be selected based on year 1 results. Samples from these wells may be analyzed for a reduced list of TCL chemicals and TAL metals, depending on results from year 1. Results from each well will be compared to concentration ranges from year 1 to determine whether any statistically significant increases in contaminant levels have occurred. For years 5 through 30 following the remedial construction, approximately eight wells will be a part of the semiannual ground-water monitoring program. The details of this program (specific wells and sample parameters) will depend on sampling results from the first 4 years.

The reduced ground-water monitoring program beyond year 1 is based on the assumption that ground-water contamination levels will remain similar to levels measured during the RI. However, if higher levels or significant increases from year 1 monitoring results are found, the monitoring program will be reevaluated. The detailed O&M plan submitted with the pre-final design will include contingencies for increased contamination levels.

The ROD also requires quarterly monitoring of surface water in the drainage ditch east of the landfill. However, drainage improvements included in the remedial design will prevent water from accumulating in the ditch except during flood conditions. Therefore, it is unlikely that surface water monitoring will be required.

10.3 OTHER O&M ACTIVITIES

Other O&M activities include inspecting and maintaining the landfill cap, the drainage ditch area, and the site gate and fencing. The O&M activities could also include visits by the Ohio Division of Wildlife to inspect and ensure proper development of the wetland area. The

O&M activities on the landfill include mowing the vegetation and removing saplings, reseeding areas where grass has died, inspecting the cap visually for sink holes and cracks and repairing those areas, inspecting the riser pipes for the gas venting system, and inspecting the sheet piling for any separation. The O&M activities at the drainage ditch include inspecting and cleaning the culvert as necessary. The O&M activities concerning the site gate and fencing include checking the condition of the locks, fence, and signs, and repairing these items as necessary.

11.0 CONSTRUCTION SEQUENCE AND SCHEDULE

The cover system and related work will be constructed in stages to allow for easier control of the work. Every effort will be made to limit the exposure of waste to the environment when surface debris and vegetation is removed from the landfill surface. The construction procedure is described in the stages listed below. The stages are described as activities in the approximate order of occurrence; however, some activities will be conducted simultaneously to optimize efficiency and minimize construction time.

1. Mobilization will begin and trailers, office trailers, power, security (including temporary fencing), sanitary facilities, and other support facilities will be installed.

2. Staging areas will be set up, as well as a decontamination pad for equipment and decontamination facilities for workers.

3. Trees and brush from the landfill will be cut, chipped, and stockpiled. Tree stumps will be ground in place, and the surface of the landfill will be cleared of debris such as tires, drums, appliances, and auto parts. The debris will be decontaminated and disposed of off-site.

4. The drainage ditch on the east side of the landfill will be dewatered, the debris removed, and the sediments excavated and placed on the landfill.

5. Steel sheeting will be installed at the southern tip of the landfill and at the northwest tip of the landfill near the Scioto River.

6. Debris from the southern end of the landfill and from the small berm at the southwest end of the landfill will be excavated and placed on the landfill. The surface of the landfill will be rough-graded.

7. Topsoil from the west and north fields will be stripped and stockpiled adjacent to the landfill.

8. A grading layer will be placed on the top and the sides of the landfill. The entire landfill will be uniformly graded and compacted, and the side slopes established.

9. Perforated headers and risers for the gas venting system will be installed in the grading layer bed.

10. Clay from the west and north fields will be excavated, placed on the landfill, and spread in four lifts.

11. Each clay layer will be compacted using sheeps-foot rollers until the 2-foot clay cap is completed.

12. The topsoil cover will be placed immediately after placing the clay layer and will be compacted in four lifts.

13. Wood chips from the trees and brush will be mixed with the stockpiled topsoil. The remaining material will be burned, if permitted. The final

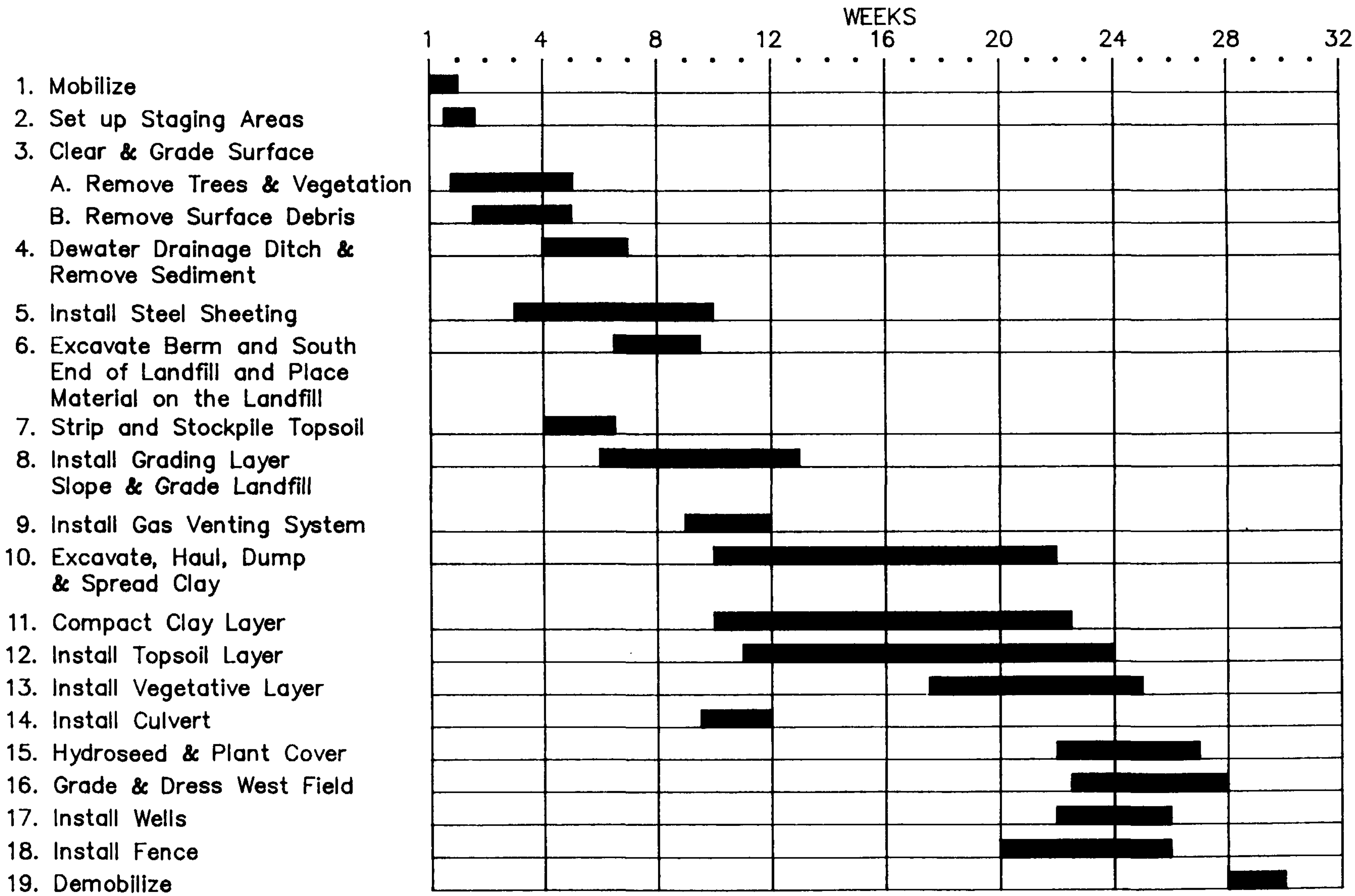
vegetation layer, including a soil confinement system for erosion protection, will be placed and compacted.

14. The drainage on the east side of the landfill will be improved, including installation of a 36-inch-diameter concrete culvert and headwalls.
15. The final vegetation layer will be seeded as soon as practical.
16. The west field area will be graded to create a wetland.
17. Three new well clusters will be installed.
18. The site will be fenced and signs will be posted.
19. Site demobilization will begin.

The Bowers Landfill Cap Construction Schedule (Figure 11-1) illustrates time frames required to accomplish the construction activities. Some of the activities will be conducted simultaneously to optimize efficiency and minimize construction time. The total construction time will be approximately 30 weeks, assuming that the construction is done in one season (if the job is bid at the end of a winter season and construction starts at the beginning of the spring season). If the construction takes two seasons to complete the work, the overall construction cost will increase.

FIGURE 11-1

BOWERS LANDFILL CAP CONSTRUCTION SCHEDULE



12.0 PRELIMINARY PROJECT COST ESTIMATES

The preliminary project cost estimates for the construction and O&M of the Bowers Landfill cap are presented in Table 12-1. The costs presented in Table 12-1 were prepared in accordance with guidelines as defined by the American Association of Cost Engineers. The information used in determining various line items was obtained from Means Heavy Construction Cost Data (1990) fourth edition, previous projects, and personal experience in the construction field. All costs have been adjusted to 1990 dollars.

TABLE 12-1

PRELIMINARY CONSTRUCTION COST ESTIMATES
BOWERS LANDFILL
CIRCLEVILLE, OHIO

Item		Description	Quantity	Unit	Unit Cost	Total[a]
1		**Landfill Area -- Clearing and Grubbing**				
	A	Medium to light trees; cut, chip, and stockpile	18	Acre	$ 2,400.00	$ 43,000
	B	Heavy brush; cut, chip, and stockpile	18	Acre	2,000.00	36,000
	C	Chip stumps in place	18	Acre	2,000.00	36,000
		Subtotal Clearing and Grubbing				$ 115,000
2		**Surface Debris Removal**				
	A	Clear, decon, and dispose of exposed drums, appliances, and auto parts		L.S.	$ 20,000.00	$ 20,000
	B	Clear, decon, and dispose of tires and demolition debris		L.S.	20,000.00	20,000
	C	Clear and dispose of surface debris on east side of drainage ditch		L.S.	46,000.00	46,000
		Subtotal Surface Debris Removal				$ 86,000
3		**Construction of Landfill Cap**				
	A	Fill material for regrading the landfill to accept clay cover, complete compacted in-place	40,000	c.y.	$ 4.40	$ 176,000
	B	Strip and stockpile top soil at west field	120,000	c.y.	.50	60,000
	C	Excavate and haul clay from west field to the landfill; dump with rough grading	60,000	c.y.	6.70	402,000
	D	Spread and grade dumped clay and compact in 8-inch lifts	60,000	c.y.	2.50	150,000
	E	Load stockpiled top soil, mix with wood chips, haul, dump, spread, compact, and grade	120,000	c.y.	4.90	588,000
	F	Grade and dress west field after excavation	220,000	s.y.	0.40	88,000
		Subtotal Construction of Landfill Cap				$1,464,000

TABLE 12-1 (Continued)

PRELIMINARY CONSTRUCTION COST ESTIMATES
BOWERS LANDFILL
CIRCLEVILLE, OHIO

Item		Description	Quantity	Unit	Unit Cost	Total[a]
4		**Erosion Control/Slope Protection**				
	A	Steel sheeting 40-foot long 38 psf left in-place	800	ton	$ 950.00	$ 760,000
	B	Polypropylene mesh for slope erosion control	53,500	s.y.	2.10	112,000
	C	Hydroseeding with mulch and fertilizer top and slopes of the landfill	900	M.S.F.	34.00	31,000
		Subtotal Erosion Control				**$ 903,000**
5		**Dewater and Clean Drainage Ditch**				
	A	Dewater ditch[b]	60	day	$ 700.00	$ 42,000
	B	Remove and decon debris from drainage ditch		L.S.	50,000.00	50,000
	C	Clean drainage ditch	6,000	c.y.	2.80	17,000
		Subtotal Dewater and Clean Drainage Ditch				**$ 109,000**
6		**Excavate Material Buried in the Road Southeast of the Landfill and in Southwest Berm**	9,000	c.y.	$ 6.00	**$ 54,000**
7		**Gas Collection**				
	A	Header with silt sock, 6-inch-diameter	4,000	L.F.	$ 2.00	$ 8,000
	B	Gas vents	6	each	300.00	2,000
		Subtotal Gas Collection				**$ 10,000**
8		**Culvert**				
	A	36-inch-diameter concrete pipe	120	L.F.	$ 60.00	$ 7,000
	B	Headwall	2	each	2,000.00	4,000
		Subtotal Culvert				**$ 11,000**
9		**Seed and Plant the West Field after Construction, with Mulch and Fertilizer**	1,000	M.S.F.	$ 34.00	**$ 34,000**

TABLE 12-1 (Continued)

PRELIMINARY CONSTRUCTION COST ESTIMATES
BOWERS LANDFILL
CIRCLEVILLE, OHIO

Item		Description	Quantity	Unit	Unit Cost	Total[a]
10		**Site Restrictions**				
	A	Remove existing fence		L.S.	$ 5,000.00	$ 5,000
	B	Install security fence	6,000	L.F.	11.15	67,000
	C	Corner posts	25	each	82.00	2,000
	D	Double-swing gate, 20-foot opening	2	each	1,650.00	3,000
		Subtotal Site Restrictions				$ 77,000
11		**Bond, Insurance, and Permits**		L.S.	$ 50,000.00	$ 50,000
12		**Temporary Facilities (Engineering field office, decon equipment, part-time security including temporary fencing, etc.)**	12	month	$ 1,750.00	$ 21,000
13		**Nine 2-inch-diameter Wells Installed in Clusters, Complete, In- Place**	400	L.F.	$ 80.00	$ 32,000
14		**Miscellaneous**		L.S.	$ 50,000.00	$ 50,000
		Estimated cost of project			**Subtotal**	**$3,016,000**
		Supervision & administration during construction	10%			302,000
		Engineering & design during construction	1%			30,000
		Bid contingency	15%			452,000
		Contingency for change	8%			241,000
		TOTAL CAPITAL COST				**$4,041,000**
		For estimating purposes use				**$4,000,000**

Notes:

[a] The figures in the total cost column have been rounded to nearest $1,000.
[b] Assumes that dewatering will be required for 60 days over a 1-year construction period.
L.S. Lump sum
c.y. Cubic yard
s.y. Square yard
M.S.F. 1,000 square feet
L.F. Linear foot

TABLE 12-1 (Continued)

PRELIMINARY O&M COST ESTIMATE
BOWERS LANDFILL
CIRCLEVILLE, OHIO

Item	Description	Quantity	Unit	Unit Cost	Total	Present Worth of O&M Costs[a]
1	**Ground-Water Monitoring and Reporting**					
Year 1:						
A	Sample collection	6	rounds	$ 12,000.00	$ 72,000	
B	Analysis of ground-water samples	210	samples	1,200.00	252,000	
C	Report preparation	6	reports	1,000.00	6,000	
	Subtotal				$ 330,000	$ 300,000
Years 2 to 4:						
A	Sample collection	4	rounds	$ 8,000.00	$ 32,000	
B	Analysis of ground-water samples	80	samples	500.00	40,000	
C	Report preparation	4	reports	750.00	3,000	
	Subtotal				$ 75,000	$ 170,000
Years 5 to 30:						
A	Sample collection	2	rounds	$ 5,000.00	$ 10,000	
B	Analysis of ground-water samples	20	samples	300.00	6,000	
C	Report preparation	2	reports	500.00	1,000	
	Subtotal				$ 17,000	$ 106,000
	Subtotal Ground-Water Monitoring and Reporting					$ 576,000
2	**General Maintenance (Years 1-30)**					
A	Mowing landfill (four mowings/year)	3,485	M.S.F.	$ 20.00	70,000	
B	Erosion protection and drainage maintenance			at 5% of capital cost 1,012,000[b]	50,000	
C	Landfill repairs			at 2.5% of capital cost 1,464,000[c]	37,000	
D	Miscellaneous		L.S.	$ 10,000.00	10,000	
	Subtotal General Maintenance				$ 167,000	$1,574,000

TABLE 12-1 (Continued)

PRELIMINARY O&M COST ESTIMATE
BOWERS LANDFILL
CIRCLEVILLE, OHIO

Item	Description	Quantity	Unit	Unit Cost	Total	Present Worth of O&M Costs[a]
	PRESENT WORTH OF TOTAL O&M COSTS					**$2,150,000**
	Total Capital Cost					**$4,000,000**
	TOTAL PRESENT WORTH					**$6,150,000**

Notes:

[a] Present worth calculated over 30 years at a 10 percent interest rate.

[b] Capital cost of Items 4 and 5 in preliminary construction cost estimate.

[c] Capital cost of Item 3 in preliminary construction cost estimate.

13.0 CONSTRUCTION QUALITY ASSURANCE PLAN

PRC will prepare a construction quality assurance (CQA) plan to be followed during construction of the remedial action for Bowers Landfill. PRC will submit a draft version of the CQA plan with the pre-final design. After addressing U.S. EPA and OEPA comments, PRC will submit a final CQA plan with the final design.

In developing the CQA plan, PRC will follow procedures recommended in U.S. EPA's Technical Guidance Document on Construction Quality Assurance for Hazardous Waste Land Disposal Facilities (U.S. EPA, 1986c). The CQA plan will cover the responsibility and authority of organizations involved in construction, CQA personnel qualifications, inspection activities, sampling and testing requirements, and CQA reporting and documentation requirements. Each of these items is described briefly below.

Responsibility and authority -- The CQA plan will outline the responsibility and authority of all organizations that may be involved in constructing the remedial action. These organizations may include construction contractors, government agencies, CQA personnel, technical consultants, and others. The CQA plan will define lines of communication among these organizations and help facilitate effective decision-making during construction.

CQA personnel qualifications -- The plan will describe qualifications that should be met by personnel who may serve as a CQA officer or CQA inspectors. The plan will identify the training and experience needed to fill these positions, given the specific components of the remedial action for Bowers Landfill.

Inspection activities -- The CQA plan will summarize the observations and tests needed to monitor construction of the remedial action. Inspections should verify that (1) construction activities are conducted as required by the approved RD; (2) work is being conducted in compliance with environmental regulations; and (3) approved health and safety procedures are being followed. This section of the plan will also describe preconstruction inspection requirements and pre-final and final walk-through inspections to be conducted when the construction of the remedial action is complete.

Sampling and testing requirements -- The CQA plan will identify sampling and testing activities that must be conducted to verify that construction is done according to specifications. Examples include permeability tests and compaction tests for each lift of the clay cover. The plan will describe test methods, sample sizes, sampling locations, sampling frequency, acceptance and rejection criteria, and methods for correcting problems identified by testing.

Reporting and documentation requirements -- The plan will describe the reports needed to document CQA inspection activities. These reports may include daily summary reports, inspection data sheets, problem identification and corrective measures reports, acceptance reports, and final construction documentation. This section of the CQA plan will also address report distribution, document control, and records storage requirements for the project.

14.0 HEALTH AND SAFETY PLAN

PRC will prepare a health and safety plan (HSP) for use during the construction of the remedial action at Bowers Landfill. This remedial action (RA) HSP will be based on the HSP prepared for RD field work (PRC, 1990e). The plan will account for any new information on contaminant levels obtained during the RD studies. PRC will submit the draft RA HSP with the pre-final design. PRC will submit a final RA HSP, addressing U.S. EPA and OEPA comments on the draft, with the final design.

The RA HSP will include two key components. First, the plan will identify protection levels and health and safety precautions to be followed by on-site construction workers and construction oversight personnel. For example, replacing the drainage pipe at the southern end of the landfill and removing debris at the site entrance will require excavating some landfilled materials. The HSP will specify any special safety measures that may be needed for these and similar RA activities. The HSP will also include appropriate contingencies to be followed in case potentially hazardous materials, such as buried drums, are found. Second, the plan will describe measures to ensure the safety of nearby residents during construction. This second component is needed because construction activities can disrupt the current landfill cover and potentially release contaminants to the air. The results from the soil gas survey (Section 3.2) suggest that air emissions of VOCs during construction of the remedial design are not a major concern for an on-site worker or off-site residents near the landfill. Nevertheless, the RA HSP will identify air sampling and monitoring requirements to detect releases; mitigation measures that can be used to control releases; and emergency notification procedures that can be implemented to protect the public.

15.0 DRAWINGS

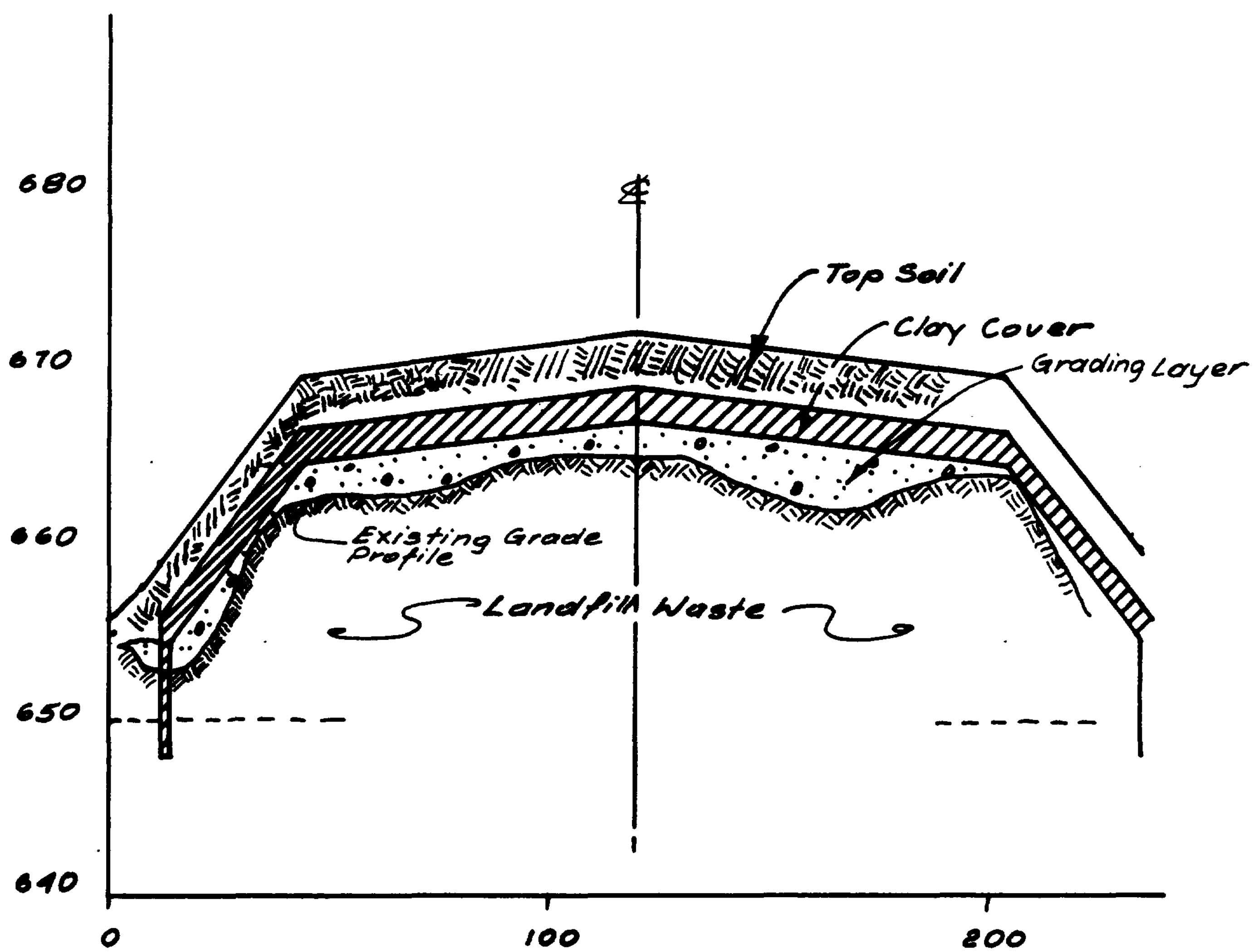
This preliminary design report includes sketches of a typical cross-section of the landfill (Figure 15-1), a cross-section at the southern end (Figure 15-2), a cross-section at the northwest end (Figure 15-3), a 6-inch-diameter gas venting detail (Figure 15-4), and a topographic map of Bowers Landfill. Additional drawings will be included with the pre-final design.

PRC Environmental Management

PROJECT Bowers Landfill NO. 0300019PO 1 OF ___ SUBJECT Typical Cross Section Landfill Cover

DESIGNED AJS DATE 9/10/90 CHECKED ___ DATE ___

Scale:
Horiz: 1" = 40'
Vert: 1" = 10'



TYPICAL CROSS SECTION

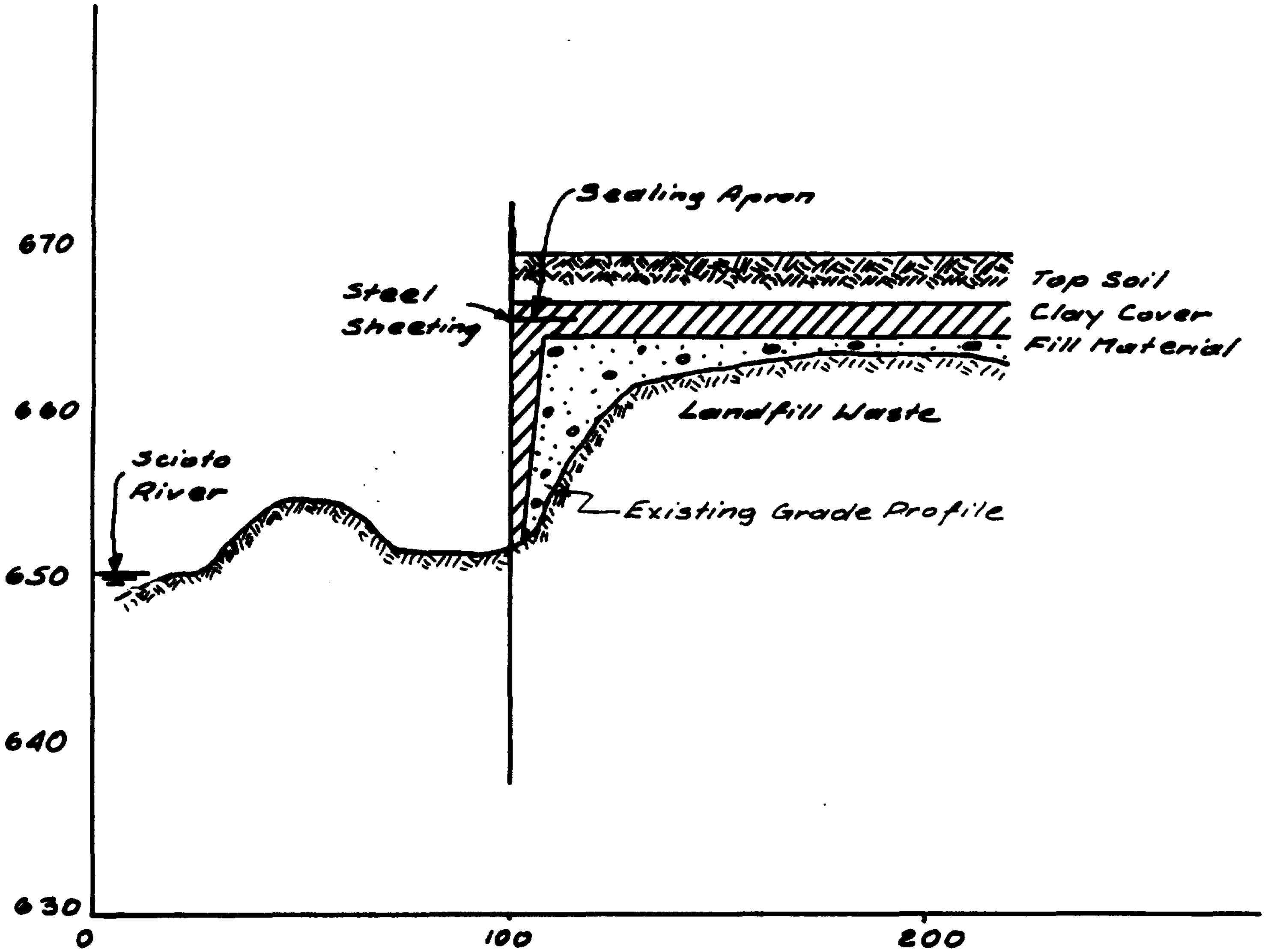
FIGURE 15-1

PRC Environmental Management

PROJECT Bowers Landfill NO. 03000019PD 2 OF ___ SUBJECT Steel Sheeting @ Southern End of Landfill

DESIGNED AJS DATE 9/10/90 CHECKED ___ DATE ___ Typical Section

Scale: Horiz 1" = 40'
Vert 1" = 10'



Typical Section @ Southern End

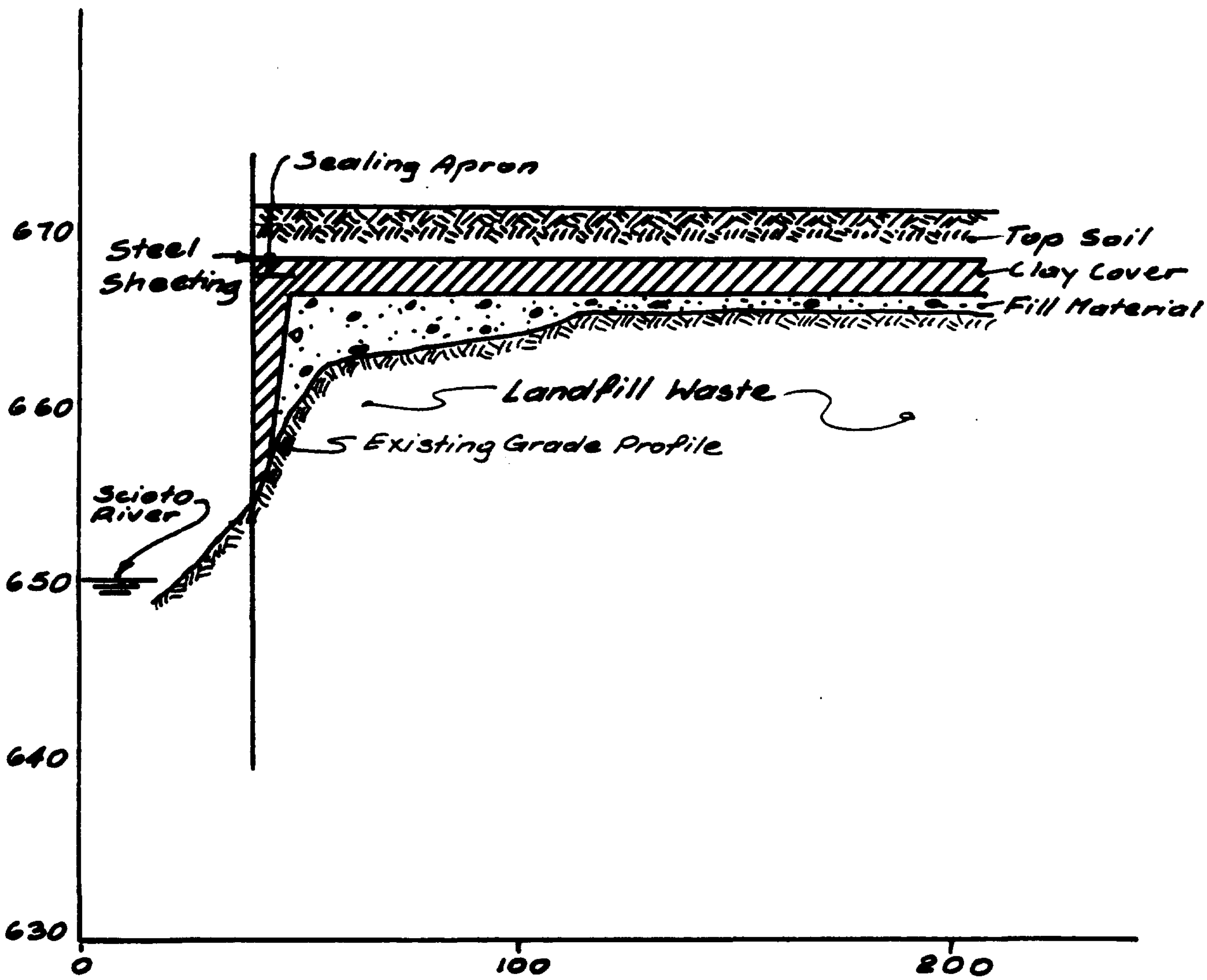
FIGURE 15-2

PRC Environmental Management

PROJECT Bowers Landfill NO. 0300019PD 3 OF ____ SUBJECT Steel Sheeting @ Northwestern End of Landfill Typical Section

DESIGNED AJS DATE 9/11/90 CHECKED ____ DATE ____

Scale: Horiz 1" = 40'
Vert 1" = 10'



Typical Section @ Northwestern End

FIGURE 15-3

PRC Environmental Management

PROJECT *Bowers Landfill* NO. *0300019PD* *4* OF ____ SUBJECT *6"ϕ Gas Vent Detail*

DESIGNED *AJS* DATE *10/5/90* CHECKED ____ DATE ____

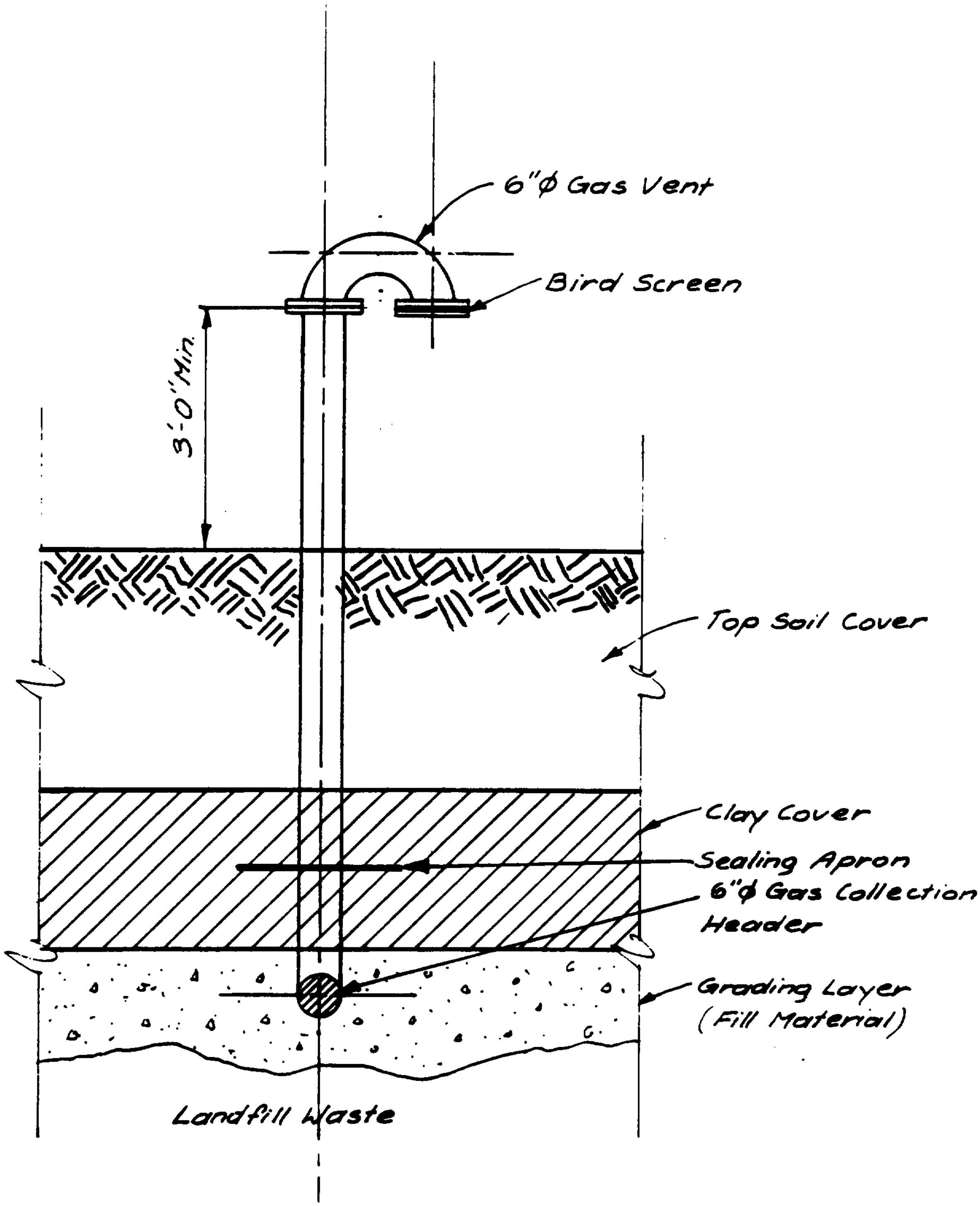


FIGURE 15-4

16.0 CONSTRUCTION DOCUMENTS

The conditions and specifications outlined below will be suitable for U.S. EPA to include within a package to solicit bids for constructing the remedial action.

VOLUME I

I. BIDDING REQUIREMENTS

- A. Invitation to Bid
- B. Instructions to Bidders
- C. Bid Forms
- D. Bid Bond

II. BID

- A. Bid Form
- B. List of Major Subcontractors
- C. Statement of Experience

III. AGREEMENT

- A. Agreement Form
- B. Faithful Performance Bond Form
- C. Labor and Material Bond Form
- D. Certificate of Insurance
- E. Affidavit

IV. CONDITIONS OF THE CONTRACT

- A. General Conditions
- B. Federal Laws and Regulations
- C. Certificate of Nondiscrimination in Employment
- D. Certificate of Non-Segregated Facilities
- E. Small, Minority, Women's, and Labor Surplus Area Businesses

SPECIFICATIONS

Division 1 -- General Requirements

- 1A -- Summary of Work
- 1B -- Cutting and Patching
- 1C -- Submittals
- 1D -- Testing
- 1E -- Temporary Facilities and Controls
- 1F -- Materials and Equipment
- 1G -- Cleaning
- 1H -- Project Closeout

Division 2	--	Site Work
2A	--	Cleaning
2C	--	Earthwork
2H	--	Sheet Piling
2L	--	Site Drainage
2P	--	Site Improvements
2Q	--	Landscaping
Division 3	--	Concrete
3A	--	General Concrete Requirements
3B	--	Concrete Formwork
3D	--	Concrete Reinforcement
3E	--	Cast-in-Place Concrete
3F	--	Precast Concrete
Division 5	--	Metals
5A	--	Structural Steel

VOLUME II
(Drawings)

DRAWING NO.	TITLE
1.	COVER SHEET
2.	INDEX, GENERAL NOTES, AND LOCATION MAP
3.	BOWERS LANDFILL OVERALL PLAN - NORTH PORTION
4.	BOWERS LANDFILL OVERALL PLAN - SOUTH PORTION
5.	BOWERS LANDFILL PLAN - AREA 1
6.	BOWERS LANDFILL PLAN - AREA 2
7.	BOWERS LANDFILL PLAN - AREA 3
8.	BOWERS LANDFILL PLAN - AREA 4
9.	BOWERS LANDFILL PLAN - AREA 5
10.	BOWERS LANDFILL PLAN - AREA 6
11.	BOWERS LANDFILL PLAN - AREA 7
12.	BOWERS LANDFILL PLAN - AREA 8
13.	BOWERS LANDFILL PLAN - AREA 9
14.	BOWERS LANDFILL PLAN - AREA 10
15.	CROSS-SECTIONS
16.	CROSS-SECTIONS
17.	CROSS-SECTIONS
18.	CROSS-SECTIONS
19.	CROSS-SECTIONS
20.	CROSS-SECTIONS
21.	CROSS-SECTIONS
22.	LANDFILL PROFILE
23.	LANDFILL PROFILE
24.	DITCH PROFILE
25.	STANDARD DETAILS
26.	STANDARD DETAILS
27.	WETLAND CONTOUR MAP

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